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INTELLIGENCE AND IMITATION IN BIRDS; A CRITERION OF IMITATION

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I.	Introduction	I
II.	Methods of Experimentation	6
III.	Results of Experiments	
	Series A. English Sparrows and Cowbirds	9
	Series B. The Male English Sparrow and the Female Cowbird of the previous series	18
	Series C. English Sparrows and Cowbirds with Old Form of Food-box	24
	Series D. English Sparrows, Cowbirds and a Junco	27
	Series E. This Junco, a White-throated Sparrow, Field Sparrows, a male English Sparrow and a young Song Sparrow	32
	Series F. The Field Sparrows, the Junco, and the male English Sparrow of Series E.	37
	Series G. A pair of Bluebirds and White-crowned Sparrows and two each of Juncos and Fox, Song, and Tree Sparrows	38
	Series H. A pair of Blue Jays	43
	Series I. Two male Baltimore Orioles, three Cowbirds and two young English Sparrows	47
	Series J. Three Crows	55
VI.	Discussion of Results	65
VII.	Summary	69

I. INTRODUCTION

If in reply to the question "Do birds imitate one another?" the writer should answer merely in the affirmative, what would such a statement mean? To most people it would mean that birds individually seeing other birds perform a certain act, say pulling a string to open a door, copy this act more or less consciously and purposefully with a definite end in view. Such a reply would be understood to mean that all imitation is identical with that which conscious or possibly self-conscious adult human beings find in themselves. Perhaps a more schol-

arly and certainly a more academic response to such a query as the above would be to ask in turn "what kind of imitation do you want to know about?" With such a way of acting, or of getting things done, as that of imitative functioning which is felt to occupy such a large place in both animal and human mental development there are very probably different stages or levels. Indeed, these stages may be so well marked as almost to demand the assertion that there is imitation of different kinds. Without, however, maintaining that the results which we have obtained in our study of birds require us to go quite so far, it is hoped that the present and later papers will afford ample proof of the fact that in learning an action through imitation many species of birds do not imitate in the same way as human adult.

No student at all in touch with recent tendencies and problems in Psychology or in the study of Animal Behavior can question for a moment the possible practical value of a study of imitation in animals. The work of the student of animals will certainly be found to be valuable for the Experimental Pedagogy of which we hear so much at present. Not so much that direct application of conclusions will be possible as that methods and conditions of experimentation which one must perforce use with animals in order to determine accurately just the factors involved will be found at least of suggestive value to the student of Child Psychology, Experimental Pedagogy, and, most of all, Social Psychology. For some years the writer has found the principle of "trial and success" or "trial and error," as it is most commonly called, one of the most fruitful with classes in Social Psychology. It is the critical use of this and the results obtained by students of Animal Behavior, particularly on Instincts and Imitation, which constitutes one of the excellent points of that recent book by Davis on Psychological Interpretations of Society.¹

The following may serve to indicate further the writer's feelings as to the probable bearings of the present studies of imitation in animals: Professor Royce, in "The Imitative Functions and their Place in Human Nature," *Century Magazine*, 1894, says, "As regards the uses and the results of the imitative functions in human life, the foregoing general indication of their breadth and depth is only the merest beginning of a comprehension of the part they play in our education and

¹ Professor McDougall's book, "An Introduction to Social Psychology," is in the first part very promising from the genetic point of view, but the later discussion is, to say the least, somewhat disappointing. Professor Ross's *Social Psychology* makes little attempt to analyze definitely either Suggestion or Imitation, much help in which is to be had from the study of animals as well as children.

in our consciousness. It is not because they are common, or because they are, in deepest origin, partly instinctive, that I lay such stress upon them. It is because they are in their proper and almost inextricable entanglement with our individual or temperamental functions, absolutely essential elements of all our rationality, of all our mental developments, of all our worth as thinkers, as workers or as producers; it is, too, because of this value of imitation as the necessary concomitant, and condition, and instrument of all sound originality which is still so inadequately understood by teachers, by critics of art, by students of human nature generally—it is on these accounts that I deem the study of the imitative functions probably the most important task in the psychology of the immediate future.” In view of the analogies which we may safely infer to obtain between at least the higher animals and man, it is not too much to believe that the study of Animal Behavior may rightfully assume its part of this task.

Several years ago the writer made a series of tests on two house mice which were captured in order to prevent their interference with his work with the birds. They, of course, liked the bird food, and, indeed, in one instance one mouse went so far as to open the door before the birds came down to the box.

Having taken prisoner two of these offenders I decided to test them with apparatus similar to that used by Small in his experiments I and II (*Amer. Jour. Psy.*, XI, p. 135). The results may be gathered into a table like the following:¹

TABLE I

Results of tests with two House Mice giving time taken for the larger or smaller, or both, to find a way through the sawdust into a box in which food was placed. The time in this as in all the later tables is given in minutes and seconds.

Trial	Time	Order of Entering
1	17:	Smaller—Larger.
2	1:30	Larger—Smaller
3	2:	Larger
4	1:	Larger
5	:45	Smaller
6	2:	Smaller

The average time for the remaining thirteen tests does not fall below that for experiments 2-6 inclusive. There is the same alternation as to which first enters the box until the fifteenth test when the smaller enters first for the remainder of the series. There may be some interest for the reader in the

¹These experiments were made in the Psychological Laboratory of Indiana University.

fact that according to my observation it required something like thirty to forty-five seconds for the mice to become adapted to the light. This came upon them suddenly when I raised from over them a second box in which they habitually stayed. As a rule they began to move about only after the lapse of this length of time.

Three tests were made on the first day and four each day following. After the seventh trial the mice could not have been very hungry, as bread crusts were inside their hiding place or on the floor of the cage. Meat or most often cheese was placed inside the sawdust box as a food more to their liking and as an incentive for their digging through.

So far as this single series is concerned, the mice learned more rapidly than the white rats tested by Dr. Small with the same apparatus. The initial times are shorter and the reduction of this to a minimum is more rapid with the mice. The fact that the mice had no hiding place except as they dug their way through the sawdust, may, in connection with their greater wildness, explain why they learned more rapidly than the white rats. The minimal time is about the same for both animals. The time required for adaptation of the eyes to the light is a rather constant factor for all the trials for the mice.

Another box with a zinc door held closed by narrow paper strips secured by wax, an apparatus very similar to another of Dr. Small's boxes, was used with the mice with practically the same, though less uniform, results.

We may ask (and this is the chief reason for introducing these results just here) how are we to determine to what extent and in what sense one mouse was imitated by the other? In several of the tests the one following seemed to dig in through the banked-up sawdust in its own way. Could the action of the other be then of any more than of the merest suggestive value? Was it merely the *following instinct* which is so prevalent in many species of animals and to some extent in man? Did one use the odor left by the other and thus have a stimulus at every step? If an odor stimulus does guide the animal at each turn, then it is not following a copy furnished by another, though the human observer would be unable to distinguish what was imitation and what was not.

These mice, as well as Berry's White Rats and Cats, and also the Raccoons studied by Cole and Davis, may all use the odor left by the animal which is acting as the model. This would seem, therefore, to suggest that all odors should be thoroughly removed from the apparatus before the animal to do the imitating is allowed to try. Spaulding, in testing the learning process in Crayfish, had to do this and all would agree

that to do so for tests of imitation would be as difficult as well as more necessary.

Birds would therefore appear to be very good subjects for a study of imitation since at least the higher ones have the olfactory lobes really very little developed and they probably use the sense of smell to small extent. For them the sense of sight is predominant as it is in man. In fact a good argument might be made to show that it plays even a larger rôle with birds than with almost any other animal. Edinger's work has shown how the keenness of vision, the large eye and the optic lobes enable them to see acutely and from afar. It is clear, then, that a careful estimate of the sort of contribution made by the separate sense fields is a prerequisite of the study of imitation. But what advantage is there in an animal which uses more exclusively the eye than the sense of smell as the source of stimuli which guide it to action? Obviously if our experimental apparatus were devised to appeal to the sense of smell, and if we as observers could detect that the animal, instead of acting on the odor stimulus, responded rather to the model set by another, then the odor guided animal would be the equal of those in which sight is predominant.

It is probable, however, that the eye requires in a less rigid way the following instinct. Certainly the criterion of the presence of imitation almost universally used by students of imitation, both human and animal, has shown that what the imitating animal sees done is thought to be all important. It is commonly stated that such an animal seemed to see what the animal to be imitated was doing. Seeing this, it did not work with the apparatus as it had previously done, but changed its method and followed the copy. Certainly such a standard as the above requires that the animal use the sense of sight and the more certain we are that keenness of vision is possessed by the animal the better prepared are we to start with.

Very few species of birds exist that are not the natural prey either of their own kind or other animals. To escape their enemies or to capture their prey very sudden and rapid action is absolutely necessary. The sensing of stimuli from afar and quick response is one of the most striking characteristics of birds. Can one bird imitate another and thus obtain food and escape enemies? If so, then we have in a way what may be called "vicarious functioning" to which, in fact, all imitation is equivalent. True we may find in birds no higher kind of imitation than the *following instinct*. Bird migrations and their other sorts of gregariousness in addition to the demand for sudden response mentioned above—all these emphasize the value to them of instinctive imitation. Illustrations of this

kind of imitation come very readily to mind. One bird starts to fly and the rest follow, one chick drinks and others do so at once.

The problem, then, of the present study is as follows: Can we by experiment and observation demonstrate that in these favorable subjects, the birds, facts are to be found which unmistakably point to imitation of a higher kind than the merely instinctive or the *following instinct*?

II. METHODS OF EXPERIMENTATION

The purpose of the experiments with which we are here concerned may be said to be twofold. First, to obtain a measure of the rate of learning in as many different species of birds as possible. Secondly, to determine if and just how birds of the same and different species imitate each other.

One would naturally expect that conditions favoring imitation might very well interfere with a uniform rate of learning, and *vice versa*. If two birds fight or pay attention to each other, then neither can at the same time be working to open a box by pulling strings. Nevertheless the writer regards the second aim as more important than the first. At least the present study has been made from this point of view. Results on rate of learning in birds have already been obtained in sufficient number to make later ones chiefly corroborative in value.

The method throughout has been to place on the floor of the large cage in which the birds were confined a small box to be opened. The results in series A, B, and D were obtained in an in-door cage twelve feet long six feet wide and six feet high. The top and one side were covered with white muslin. The other side was formed by the wall of the room in which there were two large windows. The two ends were of wire mesh. The floor, the window sills (the floor being on a level with these), and posts were covered with white paper in order that as much light as possible might be had for taking photographs. All photographs taken in in-door cages have been taken with the camera concealed in an inverted box placed on the floor of the large cage. This box being left in the cage all the time, the birds were quite accustomed to it. It was found that for most days in midwinter with a rapid lens and plate very satisfactory results could be obtained in 0.02-0.01 sec.

Extreme hunger has been carefully avoided. The small box most used was the same as that used with the Cowbirds and Pigeons the description of which may be found on p. 257, volume XVIII of the *Amer. Jour. Psy.* This box is twenty inches long thirteen inches wide and twelve high. From Fig. 1 it may be seen that the door is placed in the middle of the front on which last and the left end is a wire mesh covering.

The door is opened by pushing or pulling in any direction any one of the four strings which in Fig. 2 are shown in the niche to the right of the door. It is easily evident that the door may be opened in several different ways. It is thought that this seeming objection in actual experimentation proved a decided advantage with some birds.

All the birds are first fed by means of food placed in this box for some time before they are required to open the door. In making an experiment the food is placed on the inside just beyond the wires. The door is then closed. The birds are free at all times to move around the box. No bird has ever been confined in order that it might see another first open the door and then be liberated and allowed to try for itself. Such a method requires a break in the time which is certainly more difficult for the animal to cross mentally than it is for man.

As will be evident in many of the later series, the experimenter has sought whenever possible, by change to a kind of food more to the liking of some birds present in the experiment, by change in the positions of the food-pan, by changes in location of the strings on the box, by the introduction of strange, more pugnacious, younger, or more active and playful birds; by all these and other means the experimenter has sought to produce rivalry, competition, struggle, fear, new caution, interest and attention and above all a real necessity and opportunity for each animal to do something. When these conditions are obtained (and even then) our laboratory conditions are far enough from matching those in the birds' free life outside.

Some of the series may seem to the reader to have been carried to unnecessary length, yet such tests as laboratory studies permit are very foreign to birds and should, therefore, be given many repetitions. How foreign and artificial one can scarcely appreciate unless he has sat by the half hour outside the cage looking through the peep hole and watched the birds in the early tests doing everything but pulling or pushing the (to the experimenter) perfectly obvious string.

It is probably more natural for one bird to imitate another in song, or for a parrot to imitate the human voice, and yet how long often does one have to wait for results. Many repetitions of a word are often required before we expect to get any attempt at imitation. Artificial tests, then, can hardly err on the side of supplying too many opportunities for one bird to see another perform the act which is the model.

It should be added, as well worth the time and patience required, that such changes as those mentioned above, particularly those of the location of the strings, are better calculated than almost any other to put to a real test the intelligence and

power of analysis possessed by these and other animals. In the experience of the individual animal, as in human experience, there is a constant recurrence of old situations with a slightly new aspect. Tests of the power of inhibition, of analysis, as well as imitation, the writer is constrained to believe find favorable conditions as much in varied relations of the same apparatus as in refinement and multiplication of new apparatus. The same food box used with most of my birds may seem to the reader an undue adherence to the rules of scientific experimentation, but the results we trust will abundantly justify the method adopted.

The sub-title of the present paper, "A Criterion of Imitation," has reference directly to a point of method rather than that of apparatus. In an earlier paper the writer obtained some results of interest from the standpoint of Imitation when a change was made in the fastening to a box and both English Sparrows (the one accustomed to opening the door in a now impossible way and the other never having opened the box) had opportunity at the same time to do something. The first tried the old method several times in the presence of the second whereupon the second gave some signs of imitation of a rather blind and impulsive kind.

Early in the present work the writer began to make use of a certain standard or criterion of the presence of Imitation which may be stated somewhat as follows: Bird No. 1 is induced to open a box which may be done in one of several different ways. Bird No. 2 by the means indicated above is allowed to supplant No. 1. The effect of this different method of opening on the behavior of No. 1 is closely observed and recorded. The behavior of No. 2 will rarely be identical repetition. We may be fairly certain, then, that No. 1 will have furnished to him by No. 2, or *vice versa*, an example or act to imitate.

Such a criterion has certain obvious advantages. Students of imitation in animals allow No. 1 only to try to open the box but never to succeed. They then allow it to see from some place of imprisonment, or other rather removed position, No. 2 do the act of opening. No. 1 is then released to see if he will do as No. 2 did. They by this method almost certainly get less of rivalry, effective interest and attention, or of that condition of the mental which in man is so often the precondition for the performance of the imitative act. This condition is probably most often brought about through the fact that the animal or human has had previous experience with, or similar to, the act to be imitated.

Let us consider briefly a concrete case or two, more of which we shall see later. The Old Crow left at once the end of the food box, to work as the young Crow had just done on the front

side, the strings which the Old Crow had pulled scores of times in earlier tests. Would he have done so without his previous experience? This Young Crow showed signs of imitating the Old Crow most often only when the efforts of the latter were similar to those previous efforts of the former which had resulted in opening the door and thus obtaining food. English Sparrows, Cowbirds, Bluejays, Baltimore Orioles, and Crows when submitted to experiment by negative as well as positive results, exhibit behavior which makes it advisable to use the criterion as stated above. If bird No. 1 has not previously opened the box it is unlikely that it will try vigorously to do so unless the experimenter can in some way delay action on the part of bird No. 2. But, if No. 1 has previously obtained food in its own way it not only will be more likely to struggle, fight, etc., with bird No. 2, but has given the experimenter, by its previous behavior, a standard by which to judge its present behavior. As a working hypothesis and standard of interpretation the reader is asked to hold in mind throughout this paper the criterion as stated above.

III. RESULTS OF EXPERIMENTS

Series A. English Sparrows and Cowbirds

These birds, several pairs of each species, were forwarded to me in the same small box. While the large cage in which they were to be kept when experimented upon was being built they were placed in smaller cages and supplied with plenty of food, sand and water. It was interesting to see that the Cowbirds began at once on being liberated to bathe in the large water pans while the Sparrows showed a strong preference for the sand bath.

The Cowbird is much easier to keep in good condition than the English Sparrow and, I believe, than most other birds. Early in my work it was noted that the Cowbird was very attentive to the Sparrows. See Fig. 1, A. It soon developed that they were looking for parasites. Judging from the fact that I have never seen a single parasite really taken by them one would conclude that we may have to deal here with a very strong habit or probably an instinct. They look over very carefully the perches, window sashes, etc., in fact all objects where parasites might be found. It is probable that many times the Sparrows need the good offices of the Cowbird; but very early the male Sparrow learned always to keep a safe distance away. The little female Sparrow was able whenever she wished to so use her beak that the Cowbird refrained for a time from coming too near. Fig. 1 B. It is not impossible that a part of this behavior of the male Cowbird was due to the mating instinct.

After a few weeks during November the male Cowbirds began to strut and "gobble." I use here the terms for the rooster and "gobbler" because his actions and notes were strikingly similar to these, particularly the latter. Such actions were continued for two or three weeks at a time when they would cease to reappear again some weeks later. In addition to this "gobble" which is very like the call of the Red-wing Blackbird, only not so loud and clear, my male Cowbirds further expressed their good feeling by a series of notes, low, liquid and, indeed, very musical. It needs only to be heard to be appreciated and enjoyed. Especial emphasis is made of this matter of song for the reason that it has not been heard by many. The female has only the low rough call characteristic of all the Blackbirds.

This series (Series A) was begun on November 11, '06. The box was the same as that used in earlier work and described in my "Further Study, etc.," p. 257. The niche between the posts to the right of the door is designated as Place 1, the niche to the left as Place 2, niches 3 and 4 are on the left end, and niche 5 on the rear right corner. Throughout this paper the cords placed across each of these niches are referred to as string A, B, C, and D, string A being the first from the bottom.

In the first trial the female English Sparrow was successful, but only after thirty-one minutes and one hundred and thirty-nine efforts. These last statements are only in a small way indicative of the energy she expended. The "efforts" were simply those attempts which were sufficiently definite for me to count, and consisted chiefly in hops upon the left end and

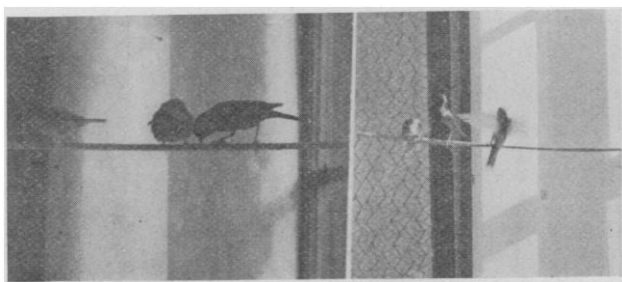


FIG. 1

A

B

The Cowbird looking for parasites on the perch and the female English Sparrow.

The female English Sparrow has resented the Cowbird's looking her over for parasites. The male English Sparrow is just alighting on the perch.

front of the box. As may be seen in the accompanying figure (Fig. 2), she opened the door in one of her first trials by

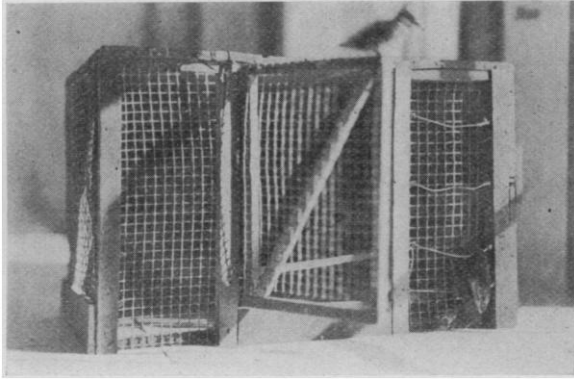


FIG. 2

The female English Sparrow (at the lower right hand corner of the box) opening the door by one of her first accidental methods. Many efforts of other kinds preceded this.

crawling in between the wire and strings and accidentally pulling on string B with the back of her head. In Fig. 3 is shown a way of opening the door which is, if such is possible,

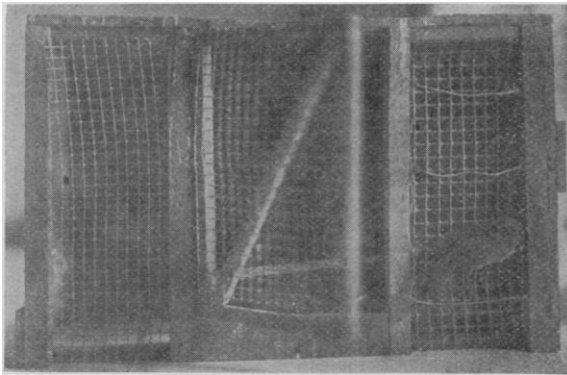


FIG. 3

The same English Sparrow as in Fig. 1 opening the door on the next day. She did not know what she had done until after she returned to the floor.

even more accidental. Here she is pushing down on string B with her head turned away from the door. She did not know

what she had done until she reached the floor and turned round. A little later in the series she hopped from the top and front edge of the box, turned as she did so, and seized the top string, D, in her claws. This is shown in Fig 4. This,

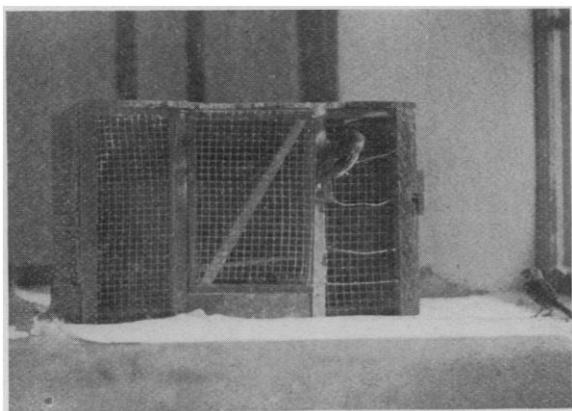


FIG. 4

The same bird as in Fig. 1. String D more directly worked with now than formerly.

with slight modifications, to be pointed out later, came to be her fixed method of opening the door. And yet she tried this

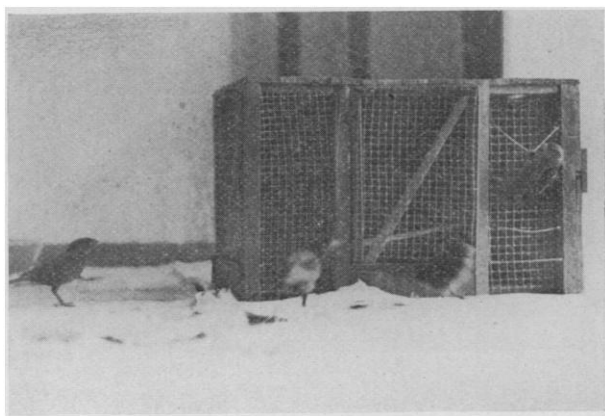


FIG. 5

The same female English Sparrow using the beak in addition to her claws. The door was rather refractory. The other birds were certainly more interested.

method only after many failures to reach the desired result through efforts very similar to those represented in Figs. 1 and 2. The reader will note that in Fig. 5 she is shown to be using the beak on the string in addition to the pull by the claws. This was done rather often when the door was a bit refractory. In other photographs not here reproduced it is shown that in the act of opening the door she scarcely stopped flying.

In one of his books C. Lloyd Morgan has called this method of animal learning that of "trial and error." This phrase has long been adopted by students of Animal Behavior. The reader will at once see that in the above series of photographs the writer was fortunate enough to obtain from this initial series a succession of this "hit and miss" or "try, try again" method purely accidental at first with the simplest and most direct act gradually selected. There is no question but that it is distinctively the animal method of learning. It means that successes are followed up because of the reward or pleasure (food in this case) which they bring. It means failures or less direct methods are discontinued because of the lack of satisfaction or pleasure.¹

In the accompanying table are recorded some of the results of this first series of experiments. For lack of space many of those results which merely show a reduction in time required are omitted. With this and succeeding tables the reader is to infer that no significant change occurred in those cases which are omitted. The times are given in minutes and fractions thereof, and the number of errors is also given. Attention may at once be called to the fact that the times are not so rapidly and uniformly reduced to a minimum as in earlier experiments with the same birds, and as will be shown in later experiments with different birds, but it must be kept in mind that the number of efforts and not the time is the better measure. And also if this better measure does not show rapid learning, it should be remembered that rate of learning is not that in which we are primarily interested. Imitation is our first interest in these tests. It will be seen many times before we conclude, that a longer time or many efforts, extreme cau-

¹The writer feels impelled to suggest that if Principal Morgan's phrase were revised to read "trial and success" instead of "trial and error" it would much more satisfactorily express what is here needed. The words "trial and error" express the unpleasant, the non-satisfying, the negative aspect of these responses while "success" could be expected to carry with it more directly the pleasurable and positive aspect. Some may point to the unwisdom of such a change when the phrase has become one of our stock-in-trade. The answer might be, however, that our science of Animal Behavior is still in its earliest infancy when changes are most easily made.

tion, lack of pugnacity, lack of fear, and many other apparent disturbances may be just the condition which shall allow the other birds, those not opening the door, to give evidence that they have the capacity to learn vicariously or through Imitation.

In the present series the female Sparrow was not in normal condition much of the time. The male Sparrow was very wild. The Cowbirds were not nearly so active as the Sparrows and usually made very few efforts. The later photographs show, however, that they learn to be present when the door is opened. They are certainly more attentive and interested if behavior is any criterion.

TABLE II

Results obtained with a pair of English Sparrows and Cowbirds.

Trial	Date	Time	Bird opening Box	Efforts by Bird opening box and other behavior
1	11-16	31	Female Eng. Spar.	140
2	"-17	12	"	56
3	"-17	23	"	Not hungry.
4	"-18	2	"	1
5	"-18	8:45	"	
6	"-19	5:40	"	3
7	"-19	1	"	4
8	"-20	3	"	6
9	"-21	:35	"	1
10	"-21	8:25	"	23
11	"-22	5:20	"	1
12	"-23	1:05	"	1
13	"-23	:50	"	2
14	"-24	:50	"	2
15	"-24	1:15	"	3 On strings after door was open.
26	"-30	11:10	"	2 Escaped from cage and had to be caught.
27	12- 1	13:45	Male Sparrow	14 Not certainly imitation.
28	"-1	5:30	"	May be done in similar way due to great fear.
29	"-32	2:45	Female Sparrow	1
32	"-1	36:15	Male "	20 Female not hungry because she escaped from cage and found food.
33	"- 4	10:20	Female "	2
60	"-21	:17	"	1 On string once after door was open.
61	"-22	3:00	"	1 In poor condition.
65	"-31	12:35	"	1
66	1- 1	2:25	"	1 Male apparently imitating a good deal.
71	"- 5	4:10	"	9 Strings to opposite side of door, place 2.
72	"-6	6:00	"	11
73	"- 6	6:00	"	6
74	"-6	1:50	"	1
75	"- 7	:35	"	1

TABLE II—*Continued*

Trial	Date	Time	Bird opening Box	Efforts by bird opening box and other behavior
81	1-10	3:35	Female Sparrow	3 In poor condition.
82	" "	:25	"	1
83	" "	:40	"	2 Strings to left end, place 3. See Fig. 8.
84	"-11	1:33	"	1
85	" "	:12	"	1
94	"-14	:23	"	1 Strings to rear on left end, place 4.
95	" "	2:10	"	5
96	"-15	:16	"	1
103	"-19	1:08	"	1 Rear side of box changed so that there are posts and wire there. Disturbed.
104	" "	:12	"	1
105	"-21	:18	"	1
111	" "	:05	"	1
112	"-22	:36	"	1 Strings now on rear side, right corner, place 5.
113	" "	:15	"	1
114	" "	:17	"	1
125	2-1	:50	"	1
126	"-2	:26	"	1

NOTE. The results omitted from the above and following tables do not add anything to the typical results which are here given.

Very early the female Sparrow was seen to take her position on the front edge of the box and hop on the strings although the door was already wide open. Most often, of course, she did not do this. The occasion for this needless repetition lay in the fact that both Cowbirds early in the series came to be, with respect to food, what they are in the wild in the rearing of their young,—a kind of parasite. They waited until the door was opened and then went in to eat. They were nearly always the first to enter. There were often pitched battles in which the little female Sparrow was often victor. But the male Cowbird was on the whole too large for her. If he entered first, and soon left she approached the box and, this first link in the chain of reactions having been performed, the others followed; she pulled the string with the door already open. She did this on the 11th, 12th, 15th, and 60th trials. In earlier work I found the Pigeons and Cowbird doing the same thing. As will be seen later, it has been observed with nearly all of my birds. Taken in themselves such errors are perhaps of little value. As indications of the degree to which the bird analyzes the apparatus it is working with, as an index therefore of the extent to which the animal is conscious, they are most significant and important.

It should be noticed that the male Sparrow on the 28th and 32nd tests opened the door. He actually did it by hopping up

on the strings from the floor. As he was very wild, he never really alighted on the strings. He made many trials that were very similar to those of the female Sparrow. For the reason that she was not in good condition, her attempts to open the box were much delayed. Thus an abundant opportunity to open the door was offered the male.

Both his unsuccessful and his successful attempts, certainly the former, would, according to previous standards of imitation, without doubt be classed as due to imitation. It seems best, however, to delay such a classification until our tests have multiplied in number and other birds of the same and different species have been tried.

It has always seemed to the writer that students of Animal Behavior, particularly those who work with the higher animals, were in danger of overdoing the simple tests which deal only with simple association processes. As Professor Mills has pointed out, our tests should show the power of the animal in question to inhibit old associations and form new ones. Many of the series described will therefore have to do with changes in the location of the strings such that the above powers will be put to the test. Furthermore such modifications will also serve the very useful purpose of giving those birds expected to do the imitating the opportunity to manifest any tendency which they may have in reality to do so.

Accordingly after a series of seventy-eight tests during the second half of which the errors of the female English Sparrow were very few, the strings were changed to Place 2 on the opposite side of the door. What, now, is the effect on her behavior? In the part of the table following, "strings to opposite side of door," we see that at first she made numerous errors. But it is of interest to note that four of the nine errors in the first trial are on the new side, and are made because more force is required to open the door now. Of the eleven errors in the second trial, six are on the new side. In the third trial she went but twice to the old side, where there were no strings. In Fig. 6 we see that she came to use the beak in this series as well as in the first. It is only fair to state that about one-half the above errors are clearly due to the fact that her weight was not enough to pull up the latch. In fact by the third trial she had learned to wriggle while seizing the string in her claws. The left side of the door or this part of the box now seemed to be the more interesting to the male English Sparrow.

In that part of the table immediately following "strings on left end at front corner" (Fig. 7) we see that all eleven trials are without error except the first where there is but one. My notes record the fact that she inhibited the impulse to jump on the old positions many times. So far as "errors" are con-



FIG. 6

The female English Sparrow of Figs. 1-5. Strings now changed to Place 2. She used the beak here also. See Table II or the text for the readiness with which this change was made.

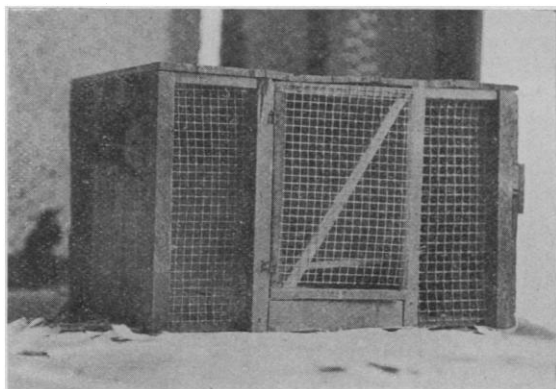


FIG. 7

Strings are shown in Place 3. See Table II or text for the way in which she learned this.

cerned, this series then, is almost perfect. Practically the same may be said of her behavior with respect to the remaining two changes,—“strings to left end at rear side” and “strings to rear side at right corner.” There are no errors at all in the last series and the errors in the second trial of the last series but one are almost certainly due to the fact that she had something wrong with one foot.

Some interesting conclusions follow from what has just been given. It is evident that after the first change in the location of the strings, these come to stand out from the other parts of the box; they are distinguished. They are singled-out-elements of a compound, and we seem to get some little beginnings of what in human minds is called "abstraction." But let me hasten to say that the reader must not think that such abstraction is conscious in at all the degree in which we find it in adult human behavior. As has been suggested above, and as will be shown later, the *cause and effect* relation probably never is felt or thought by these birds. All that is meant is that some one part, rather than a definite place to hop upon, gradually comes to be felt apart and thus impulsively to be worked with more than some other.

Series B. Male English Sparrow and Female Cowbird

These birds are those which have been with the female English Sparrow during all the previous tests. The male Cowbird had been removed much earlier for the reason that it cost the female Sparrow too much of her energy to fight with him.

It will be seen from the table below (Table III) that the rate of learning is very slow with these two birds. The times are often very long and the errors for the English Sparrow many. This is chiefly due to his extreme wildness, and were it not probable that this very wildness really plays into the hands of the experimenter the present series should be counted in large part as a failure.

It is possible that being so long accustomed to seeing the female English Sparrow open the door they now sit and wait. They have learned *not* to do instead of to do. Thus they fail in thirty minutes in the first trial and the door is opened in the second trial by accident. In the third the male Sparrow succeeds in thirty-one minutes after many trials. The manner in which the door was opened by him is of interest. The uncritical observer might call it imitation, for he flies out from the front upper edge, turns, and in his flight seizes the strings. This is very similar to the method of the female Sparrow, but I have had frightened Sparrows behave in this same way when they were alone with this box. Furthermore I have observed this reaction in the English Sparrow as it seized a feather or bit of other material in its free life out of doors.

In the fourth trial both fail in one hour. But this apparently negative result really means quite different behavior by each of the two birds. The amount of activity and therefore the energy expended by the Sparrow is enormously greater than that of the Cowbird. The former shows signs of knowing where to alight, though he cannot overcome his fright. The

TABLE III

Results obtained by continuing the tests with the male English Sparrow and female Cowbird which were in the preceding series.

Trial	Date	Time	Bird opening Door	Efforts by Bird opening Door. Other behavior.
1	2- 3	30:	Failed	
2	"- 4	58:	Male Sparrow	Many efforts. Out from top, turned and near strings.
3	"- 6	31:	" "	58 of many kinds.
4	"- 7	60:	Failed	Sparrow much more active.
5	"- "	20:45	Female Cowbird	
6	"- "	19:45	" "	Sparrow many attempts.
7	"- "	55:55	Sparrow	He worked all the time. Very wild.
8	"- 8	49:30	"	Many movements like those of female Sparrow. Has known what to do almost from the first.
14	"-12	4:30	"	So wild that did not eat inside box.
15	"-13	20:20	Cowbird	Sparrow made 36 efforts.
16	"- "	44:45	"	2 Sparrow made 77 efforts. He was not well.
19	"-15	45	Failed	
20	"- "	1:30	Cowbird	She made very few efforts.
21	"-16	2:45	"	When ready she walked up and pecked string. See Fig. 8.
22	"- "	1:30	"	
30	"-21	26:	"	
31	"- "	4	Sparrow	
32	"-22	26:30	"	With beak as Cowbird did.
33	"- "	9	Cowbird	
40	"-26	1:40	"	
41	"-27	11:20	Sparrow	
42	"- "	9:20	Cowbird	Sparrow struck top of door as Cowbird had done.
45	3- 1	25:45	Sparrow	He pulled string with bill.
46	"- "	6:40	"	" " " "
47	"- 2	12:40	Cowbird	
48	"- "	18:45	Sparrow	" " " " Fig. 9.
49	"- 3	6:30	"	He tried his own method many times.
50	"- "	6:10	"	He continued both.
51	"- "	1:05	"	" " " "
52	"- 4	23:45	Cowbird	
53	"- "	4	Sparrow	Combination. Fig. 10.
54	"- "	7:45	"	From the floor as Cowbird.
55	"- 5	17:15	"	" " " " "

TABLE III—*Continued*

Trial	Date	Time	Bird opening Door	Efforts by Bird opening Door. Other behavior.
56	3- 6	13:30	Sparrow	Combination.
57	"- 7	11:50	"	"
58	"-11	5:20	"	Cowbird often not down at all.
73	"-"	9:55	"	Female Sparrow present.
74	"-19	1:45	"	She disturbed considerably. He followed.
77	"-22	14:07	Failed	
78	"-23	13:20	Sparrow	
79	"-24	12:40	"	Another female Sparrow present.
95	4- 2	12:40	Cowbird	Strings to left of door.
96	"-"	10:40	Sparrow	As Cowbird did and as he had been doing for some time.
97	"-"	24:10	"	
98	"-"	4:20	Cowbird	Sparrow so wild he would not go in box at all.
99	"-"	11:40	"	
100	"- 3	4:25	"	
104	"- 5	9:10	"	
105	"- 6	3:45	Sparrow	
106	"- 7	38:55	"	
107	"- 8	5:15	Cowbird	
108	"- 9	7:45	"	
109	"-10	18	Failed	

Cowbird was successful during the fifth and sixth trials, Fig. 7, but as a rule (and this obtained throughout this entire series) she waited until the Sparrow had made many attempts; then she came down and by a few pecks on one of the lower strings opened the door. For example in the sixteenth, eighteenth and nineteenth the Cowbird was successful, but the Sparrow made thirty-six, thirty-six and seventy-seven efforts respectively. Although he was the one to open the door in the trials just preceding these last, his great fright and wariness would not allow him to enter the box and eat the food. His habit was to seize the bits of food and carry them out to the floor of the larger cage and eat them there. It is interesting that my notes record the fact that the Sparrow seemed ill and had seemed so for a few days previously. The Cowbird then continued to open the door until the thirty-fourth and thirty-fifth tests. In the latter the Sparrow used his beak on the string, which was the Cowbird's way of doing, Figs. 8 and 9. Some ten tests later the Sparrow came to strike with the bill the projecting upper edge of the door, a sort of effort which the Cowbird had been using for some time.

In the 48th, 49th, 51st and 52nd tests the Sparrow again used the bill to strike the first or second strings and he stood

on the floor. See Fig. 9. These would seem to be modifications of his two earlier methods. One might reasonably infer that such variants were due to the example he had had in the behavior of the Cowbird. It should be added, however, that my notes describe the efforts of the two birds in a different manner. Those of the Cowbird are designated as "mumbles

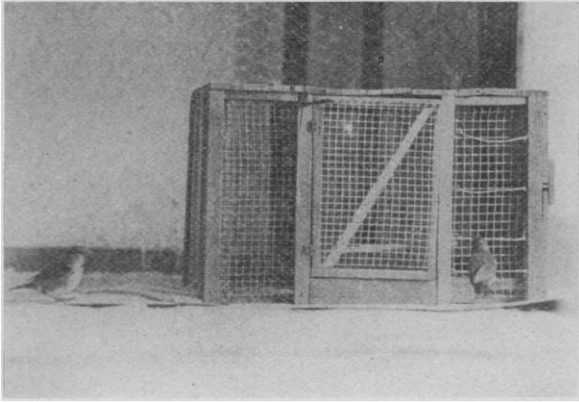


FIG. 8

The female Cowbird as she opened the door with the beak. This is a very simple way of opening the door. As a rule the male English Sparrow made many attempts before the Cowbird left the perch.

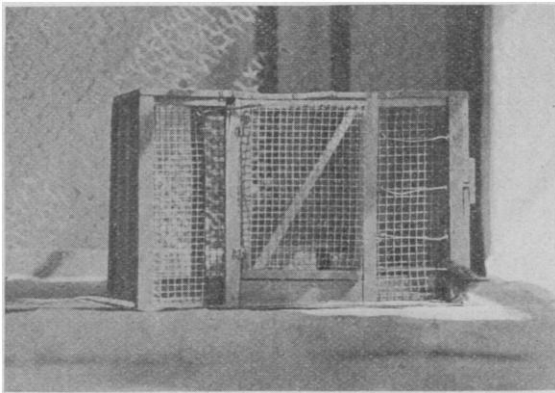


FIG. 9

The male English Sparrow as he opened the door following the times when the Cowbird had used her method shown in Fig. 8. He had been flying out from the top and alighting on the strings.

of the knots on the strings," those of the Sparrow as "pulls of the string."

In the 53rd test there occurred a change in the method of the Sparrow that should be of much interest to all students of animal and child life. Instead of using any of the methods he had up to this time employed he now alighted near the free side of the door and two-thirds the way to the top and struck the top string with his beak. A better way to express this

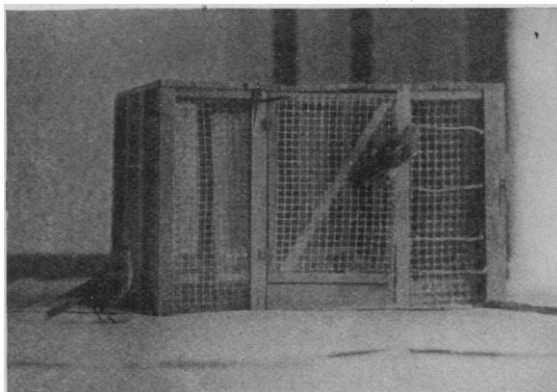


FIG. 10

The male Sparrow using his combination method. His fear seemed to be one of the chief incentives for this change from that shown in Fig. 9.

would be to say that after many attempts he succeeded in opening the door in this way. Fig. 11. In reality this method is to be designated as a combination of, at least, two of his previous methods. The writer would not have any one believe that this was a conscious invention on the part of this bird. He rather hastens to point out that such is very probably not the case. But neither are the first inventions of children consciously made. In fact such inventions as Professor Baldwin has cited and explained seem to be for the most part very similar to what is here recorded for the English Sparrow.

It was true many times that the female Cowbird did not come down at all until the door was opened. The Sparrow thus continued to open the door. A female English Sparrow was turned into the cage on the 77th test and a little later still another one. They served to distract him since he tended to follow them in their running around the box. If anything his fear which was constantly increasing was enhanced by their presence.

After the 100th trial the strings were changed to the left of

the door. The Sparrow pecked at the eyelets through which the strings passed on the old side, hopped up on the wire here and on the side where the strings were now. He seemed purposely to avoid hopping on the string. In spite of all his efforts he allowed the Cowbird to open the door in this 101st trial. But in the two following trials he was successful and performed as the Cowbird had done. In the remainder of the 115 trials he opened the door but once.

As a series to demonstrate animal stupidity the present would seem a good one. Yet as containing many results of interest to the student of imitation it is perhaps in many ways one of the best which the writer so far had obtained. There were many alternations between the two birds as to which one opened the door. The Sparrow's fright pushed him into many modifications and it so came about that he had a slow-going, timid but not wild bird as a model. Indeed, according to the writer's experience, it will seldom happen that conditions will arrange themselves in so favorable and fortuitously variable a manner as they did in this present series.

There are not many indications that the examples set by the Sparrows for the Cowbirds had any value whatever for any intelligent imitation. At the most they were only of general suggestive value and had their effect through the "following instinct." Such would fall under the head of instinctive imitation.

This is not saying that the Cowbirds are not capable of imitation of a kind higher than that which is instinctive. They may be, but not being at all as active as the English Sparrow it was not evident. Every one would agree that the manner of life of the English Sparrow for many hundreds of years has made them favorable subjects for such a study as the present one. Furthermore it should be asked,—Is it reasonable to suppose that a bird whose individual experience with this box is *nil*, or as little as that of the Cowbirds, could be expected to imitate beyond the instinctive level?

The effect on the Sparrows is quite different. They make readier use of the "following instinct" or instinctive imitation. But the chief question in this present connection is: are they able to use intelligent imitation, and in this instance was it imitation of the behavior of another species as well as that of their own? By intelligent imitation I do not mean the voluntary, reflective, intentional or rational. There may be something like the same difference between intelligent and rational imitation as has been long ago accepted between reasoned behavior and intelligent behavior. Intelligent imitation would thus require no reasoning, no very clear and definite idea of the end or re-

sult if any idea at all.¹ It would, however, demand considerable individual experience of the animal doing the imitating with the apparatus with which it is to work. The results so far obtained are too meagre to furnish us with a basis for generalization. They have suggested, however, the following questions as working hypotheses. Is it not rather futile to expect imitation above the instinctive grade of an animal without first giving it considerable individual experience with the mechanism it is to operate? Can we by allowing a bird to open a box in its own way establish a working basis for interest and attention so that if it sees the apparatus worked in a different and perhaps better way it will be led to add just a little more of the mental than is required in instinctive imitation?

A concrete illustration may help us here. The male English Sparrow toward the last of Series B, when the female English Sparrows were put in, ran round and round the box after them. This was instinctive. But he found it possible to open the box after the strings were changed to the left of the door only after the female Cowbird had done it once. If he followed her example even without appreciating the end (and I am inclined to think he did) then it is ever so slightly intelligent. At any rate we shall see what later series with many different kinds of birds will bring forth.

It would be natural to suppose that birds of any species would more readily imitate particularly in an instinctive way the actions of those of their own species. *A priori* a definite act which is to be imitated would be accompanied by more of general suggestiveness if done by one of their own kind. However, intelligent imitation based on so much of individual experience as was the case with this male English Sparrow, it would seem, need not be necessarily limited by the fact that the act is performed by a bird of another species. In fact it may be found that imitation of this sort is a mark of superiority of some birds over others depending as it probably does on a greater amount of activity and therefore having a better basis in a richer individual experience. It is not impossible that imitation of the instinctive kind is more natural and likely with the same species; intelligent imitation less so.

Series C. Results of Experiments with an Old Form of Food-box on English Sparrows and Cowbirds

This series of tests was made with the birds in a somewhat

¹ The writer does not maintain that the bird does not have reaching the food as an end but an imitative act *per se* must have in it as an essential part what we might term a proximate end. To be sure there may be several of these. To be in possession of these mentally certainly presupposes certain powers of analysis though these may be of all degrees of complexity.

smaller cage. This was only some six feet square, as tall as the larger, and built on the end of this larger one. Like the large cage, the floor of this was on a level with the window-sill. My chief difficulty was with the temperature. With the direct rays of the sun coming in through the one window and the fact that but one end of this cage was of wire, the heat became too great during the middle of the day even in midwinter. The results of this series contribute little positive with reference to imitation, but the negative results obtained are of suggestive value and interesting relations of the two species have been brought out.

As the reader may gather from the accompanying figure, Fig 11, the food-box here used is identical in principle with that which I first used. Fig. 1 *Am. Jour. Psy.*, Vol. XV, p. 319. Reference to Table IV will show that the female Cowbird first opened the door. In the next trial, though she made nine efforts, the female English Sparrow was successful. She did not pull the loop or strike at the free end of the latch, but pulled at the wire hinge which fastened this latch to the door. She drove all other birds away just prior to opening the door. It should be noted that after the door was opened in the first test the Sparrows did not enter, but ate the food thrown out through and under the wire by the Cowbirds. The Sparrow's method of opening the door cannot be called an imitation of that used by the Cowbird.

During the third test and some of the succeeding ones there were pitched battles between the Sparrows and the male Cow-

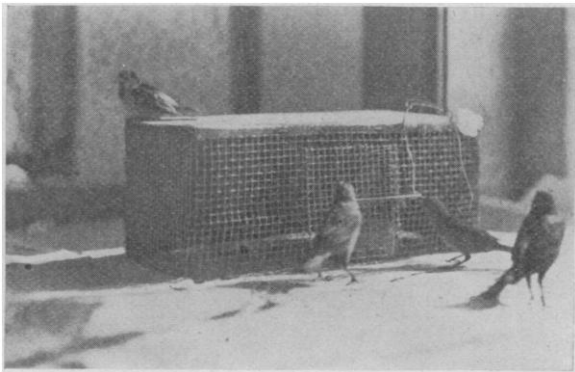


FIG. 11

Female English Sparrow opening door by pecking at the knot on the string where it passes through the latch. She repeatedly drove all the others away from the door in order to open it.

bird. Often the little female Sparrow dashed in and took food out of the Cowbird's beak in very much the same way as the English Sparrows, in their free life out of doors, may be seen to relieve the Robins of their choice worms.

At the eleventh test the string and wire were removed for the reason that the bird had now come to strike the latch where

TABLE IV

Trial	Date	Time	Bird opening door	Efforts by Bird opening door
1	2-22	23:40	Female Cowbird	7
2	"	6:40	Female Sparrow	3 Female Cowbird made 9 efforts.
3	"-23	26:50	" "	17 The Sparrow drove all others away.
4	"-24	10	" "	24 Struck some part of latch with the bill from the first.
5	"	9	" "	4
6	"-25	3:10	" "	4
7	"-26	3	" "	1
8	"	10:30	" "	18 Taking photograph a disturbance.
9	"-27	7:30	" "	8 Struck latch after door was open.
10	"	12:10	" "	9
11	"-28	2:35	" "	8
12	3- 1	23	Failed	4
13	"- 2	14:55	Female Sparrow	1
14	"	20:50	" "	3 Not in good condition.
15	"-11	4:50	" "	9 Drove both Cowbirds away from any place where she wanted to get food.
16	"-12	10:20	" "	4
17	"	14:45	" "	2
18	"-13	1:50	" "	3
19	"-14	1:40	" "	1
20	"-15	3:25	Male Cowbird	By accident as he hopped off of box.
21	"	1	Female Sparrow	4 Two other female Sparrows present.
22	"-16	2:40	Female Sparrow 2	2 by Sparrow No. 2, 1 by Sparrow No. 1, and opened by No. 2, apparently imitation.
23	"-17	1:57	Female Sparrow 1	1
24	"	1:15	" "	4
25	"	3	" "	3 Boiled rice as food.
26	"-18	:40	" "	1
27	"	:15	" "	1
28	"	:20	" "	1
29	"-19	:34	" "	3
30	"	6:25	" "	4 Probably not hungry.
31	"-20	3:55	" "	4 Time and number of efforts fairly uniform after this to the close.
32	"	1:05	" "	1
66	4-10	6	" "	1

the knotted string passed through. For the twenty-first trial two other female English Sparrows were in the cage. The one designated as No. 2 was noted as showing most promise. In the following test the latter made a few efforts, then there was one effort by No. 1, after which very suddenly No. 2 opened the door by one well placed effort.

These results, which constitute all that were obtained during this series, are insufficient to serve as proof of imitation. Female English Sparrow No. 1 was too clearly the victor and in later tests drove away others of her kind as well as the Cowbird.

It will be seen that this series furnishes us with fairly satisfactory results so far as concerns times and efforts required. Toward the close the physical condition of the Sparrows did not warrant further trials.

Some weeks later an attempt was made to test a pair of Cowbirds and a Junco with the same form of simple maze which was earlier used with a Vesper Sparrow, a female Cowbird and several English Sparrows. See *Am. Jour. Psy.*, Vol. XVII, p. 253. It is not the intention here to state in detail the results obtained. In order to avoid the difficulty encountered earlier when some of the birds caught their claws in the wire mesh which formed the floor as well as the top and sides of this simple maze, the bottom was cut out. Typical results were obtained with each bird until they formed the habit of stopping at the far corner of the maze or that part which, because of the small size of the experimental cage, was thrown very near the window and on a level with it. The birds, instead of attempting to get through the maze, were attracted toward the source of light and thus stood still or struggled to escape.

This maze is therefore an unsatisfactory test for quantitative results when used under these conditions. In fact the writer had this feeling after having made the first tests.

*Series D. A Pair Each of English Sparrows and Cowbirds
and a Single Junco*

For some years the writer had wanted to make tests similar to those made with the English Sparrow on the Junco. The reason for this is that the Junco remains in this latitude throughout the winter and lives in small groups. When a friend kindly brought me one of these birds, I lost no time in beginning work with it. It seemed none the worse for having bumped against the side of our library building. I found that it was easily kept in captivity since like the Cowbird it seemed to do much better on the various kinds of seed and cracked corn than the English Sparrow. From facts like these one may infer that the English Sparrow's rapid increase in numbers is

not due to the fact that it is more hardy than other birds. When placed in the larger one of my cages with a pair of English Sparrows and Cowbirds, the Junco spent the time during the first tests running back and forth on one of the window sills.

The male Cowbird opened the door during the first trial of this series in a purely accidental way. In the second trial the male Sparrow was successful. He did it in much the same way as the male of this same species who has figured in the earlier series A and B. His fright seemed to induce him to use this method of flying up and out and seizing the string without alighting. In the third and fourth tests the female Sparrow was successful by hopping up on one of the strings. In the fifth the Junco succeeded by striking the string with one wing as it chased the female Sparrow away from the front of the box. A great change had come in the Junco's behavior after the first trial and previous to the fourth. It chased the female Sparrow away at every opportunity, but was in turn no match for the male Sparrow. It was evident that the female Sparrow wanted to open the door. The female Cowbird remained outside the box when the Junco was on the inside.

In the sixth test the male Sparrow made an effort. The Junco chased the female Sparrow away several times. The latter was induced to run round the box several times by following the male Sparrow. Finally the female Sparrow opened

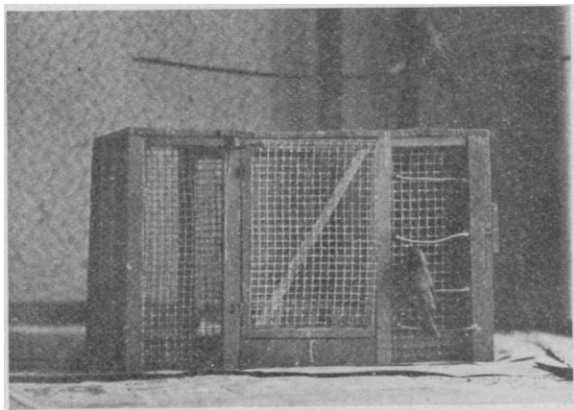


FIG. 12

The first method used by the Junco in opening the door. She must make many hops to this spot for the reason that her claws do not strike string B. The Cowbird is looking for parasites on the male English Sparrow.

the door and after the others were inside eating she jumped on the string once with the door open. In the seventh the Junco was successful, but the rival must first be chased away. Such control of the situation was not to last long, for in the fourteenth test the tables were turned and the female Sparrow proved now the better fighter. This as is stated in the table was probably due to the fact that she was not in good physical condition. It is often to be noted that such condition in the Sparrows causes them to be more pugnacious. It has been observed when these have had to chase the Cowbirds away.

The number of efforts required for the Junco to open the door was often very large and this continued throughout the whole of this series. The reason for this may be seen in Fig. 12. This bird often simply jumped astride String B without touching it. Frequently she must continue to jump until she does strike the string with one claw, usually the lower one. Certainly such a method does not point to a great degree of analysis of the task to be performed and which is performed. If she does this by imitation it is certainly of the blind sort. As to whether or not there is imitation the facts to be recorded now may give an answer.

In the seventeenth test the female Sparrow ran in from the window and made an attempt very quickly and just after the Junco had tried; when one approached the strings the other did so too. The rivalry was more intense.¹ In the succeeding test the Junco tried on the door at the same time and after the Sparrow was on the strings. Boiled rice had been placed in the box with the expectation that the female Sparrow would try harder. Such was really the case.

In the nineteenth test the female Sparrow would not allow the Junco to come near the box. During this test the reason occurred to me, for the fact that the female Sparrow finally opened the door by jumping on the top string, D. When she jumped lower than this there was space enough between the strings for her to alight without striking any of them, but not so at the top. The upper edge of the box crowded her down, as it were, so that in jumping to the wire she pushed in string D. This is strikingly similar in the lack of analysis of the relations of parts of the box to the Junco's great number of efforts, and prepares us to understand certain mistakes of the Bluebirds to be recorded later.

¹ The word "rivalry" is here used simply to indicate the struggle between these birds and does not imply that the writer regards it as the same as human rivalry.

TABLE V

Results of tests with a pair of English Sparrows, Cowbirds and a single Junco.

Trial	Date	Time	Bird opening Box	Efforts by Bird opening Box and other behavior.
1	5-22	11:	Male Cowbird	Accidental.
2	" "	22:	F. Eng. Sparrow	By flying up and while flying seizing string.
3	"-23	30:10	" "	Hopped on string.
4	" "	13:47	" "	
5	" "	3:	Junco	Struck string with wing in chasing Sparrow away.
6	" "	5:53	F. Eng. Sparrow	3 Other Sparrow tried once.
7	" "	4:53	Junco	1
8	"-24	5:43	F. Eng. Sparrow	2
9	" "	10:45	" "	1 Junco made 4 efforts.
10	" "	20:18	" "	8 Junco tried twice.
11	"-25	25:30	" "	2
12	"-26	25:10	" "	9 Junco struck at string and seemed ready to jump.
13	"-27	21:00	Junco	5 F. Sparrow not well.
14	" "	2:45	"	1 F. Sparrow and Junco were equally good fighters.
15	" "	5:05	Female Sparrow	1 on string 4. She drove Junco away.
16	"-28	16:30	Junco	11 F. Spar. 4 efforts. Rivalry.
17	" "	10:50	"	26 Rivalry more intense when one tried other followed.
18	" "	2:20	Female Sparrow	9 Junco on box as other was on strings. Boiled rice caused Sparrow to try more.
19	" "	5:30	" "	7 She did not allow Junco to try. Boiled rice caused Sparrow to try more.
20	" "	3:43	" "	1 Junco seemed to beg to be allowed to try. Boiled rice caused Sparrow to try more.
21	"-29	3:05	" "	3 Junco was driven away.
22	" "	6:24	" "	6
23	" "	1:05	" "	4 For some time she had been using string 4 probably because she was forced there from lack of space above it.
24	" "	2:30	" "	7
25	"-30	9:10	" "	18 Junco 14 efforts. No rice in.
26	" "	15:	Junco	28 Sparrow 15 efforts. No rice.
27	"-31	:30	"	5 Sparrow on door when it was opened by Junco.
28	" "	:55	"	5
29	" "	:7	"	1
30	6- 1	:17	"	1
31	" "	:28	"	1 On strings twice after door was opened.
32	" "	1:55	"	13

TABLE V—*Continued*

Trial	Date	Time	Bird opening Box	Efforts by Bird opening Box and other behavior.
33	6- 1	:57	Junco	5 Sparrow again on door as it swung open.
34	"- "	:10	"	2
35	"- 3	3:07	Female Sparrow	1 Junco 9 efforts. As often before, she failed to alight on string.
36	"- 4	:06	Junco	1
37	"- "	:32	"	9
38	"- "	1:02	"	4
39	"- "	:57	"	6
40	"- 5	:05	"	2
41	"- 5	:32	"	9 Did not seem to know yet that the string had to be pushed in.
42	"- 6	:12	"	3
43	"- "	:37	"	6 Jumped astride of string 2 as shown in figure 12.
44	"- "	:38	"	6
45	"- 7	:20	"	4
46	"- "	:30	"	1
47	"- "	:25	"	6
48	"- 8	:05	"	1
49	"- "	:30	"	1
50	"- "	:32	"	7
51	"- "	:13	"	1
52	"-10	:17	"	2

In Fig. 13 we find a very interesting condition of things. In this, the twentieth test, the Sparrow, as may be seen, is holding the strategic position, but the jump to string D requires considerable effort in her depleted condition and she is hesitating, making starts, and hesitating again. All the while the Junco with open beak is uttering the most plaintive notes. It is certain that this bird would act at once if given the opportunity. Finally the Junco really showed signs of fighting. To obtain such a situation as this is rarely possible. It would seem that such might be a very favorable condition for the appearance of imitation, and certainly no small amount of suggestion and the "following instinct."

In the twenty-fifth test and those immediately following the boiled rice was omitted in order to see what effect this would have on the efforts of the Sparrow. It is evident that soon the Junco took the lead and with one exception retained it to the close. Both made many efforts. In the twenty-eighth trial the Sparrow was on the door when it swung open. She had jumped there just after the Junco had alighted on the strings. In the thirty-third test she again did the same thing. This series, then, points to rapid learning by the Junco, but to learning the same in kind as that shown by other birds. There

is a place to be hopped upon, but no further does the analysis go. Working on this place brings a pleasurable result, but there is no analysis. The keen rivalry and almost equal fighting ability, the change in the female Sparrow's condition of health and the food more to her liking were particularly suited to bring out some evidence of imitation. This evidence is of the same kind as that in series A and B and other evidence obtained later with the Crows and Orioles. There are some changes in the behavior of both the Junco and the Sparrow, changes from what we are pretty certain would have occurred if the other bird had not been present. These would point to imitation which might be called intelligent. That is, without first giving these birds previous experience with this box we could hardly expect the definite acts called forth in each by the other. There is much proof of the "following instinct."

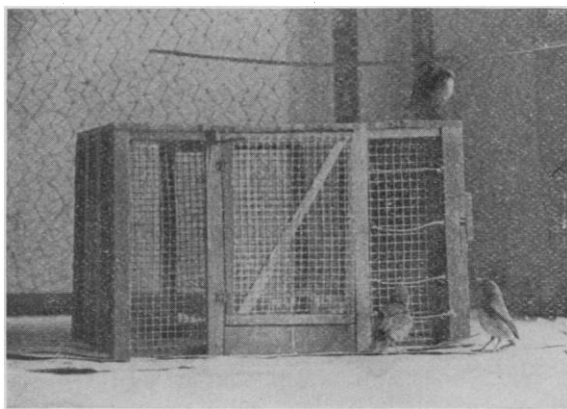


FIG. 13

The female English Sparrow was ready to jump on the top string. The Junco was standing by uttering a series of plaintive notes. These two birds often fought each other for the position in front of the strings.

Series E.

Tests with the Junco of the Preceding Series, a White-throated Sparrow, a Field Sparrow, a male English Sparrow and a young Song Sparrow.¹

¹It is a duty both pleasantly and gladly performed to be able to acknowledge at this point the courtesy and unreservedness with which Mr. and Mrs. Worthington of the "Worthington Society for the Investigation of Bird Life" placed at the writer's service for purposes of investigation every facility not only as to birds and cages at the aviary

It is well worth our while to note that this series and all that follow in the present paper were made on the birds in out-door wire cages most of which were ten feet square by six high. The conditions were very much more natural if they do not always give such uniform results as may be obtained by working on birds kept in the laboratory. Inside one can control the food supply as well as other conditions so that the birds are more hungry and undisturbed; but it is probably better to sacrifice nice uniformity for naturalness.

This series was really a Memory one for the Junco, the interval being some half a month. During this interval with three Cowbirds this bird was carried several hundred miles from the laboratory in Worcester, Mass., to Shawnee-on-Delaware, Pa., and placed in very different surroundings. The White-throated Sparrow had found its way into a wire cage at Mr. Worthington's Pheasantry, and was captured and placed in this cage. Its size and disposition, and ability to fight account for its early successes and for the long times even when the Junco opened the door. The White-throated Sparrow would not allow any of the birds to come near the box. This was not true for the first of the Junco's trials and it will be seen from the table that they were good. The short time of the Junco in the seventh trial, its first success, indicates that previous to this the White-throated Sparrow and the strange surroundings served to keep it away from the box.

The White-throated Sparrow, if we make an exception of her earlier trials, may be said to have opened the door in the manner used by the Junco. But she did not long continue this. She jumped up on the post rather than on the string. At times her efforts were as many as seventy-two and ninety-two, and largely for the reason that her efforts had to do with the post and not with the string, Fig. 14. This method was used habitually, and points to the kind of associations of which this bird was capable.

For the 129th test the food was shifted to the left side of the door, and in the next to the left rear corner. This was done with many of the birds in order to see whether it would lead them away from the strings, and cause them to work on another part of the box which was very similar in appearance to that where the strings were placed first. This change had no effect at this time, but after this bird and the Song Sparrow were transferred to another cage, such a change in the place of the food did have quite a disturbing effect. See tests 159, 160 and

but also in many other respects. My acknowledgments are gratefully made to Mr. Chas. W. Miller, Director of the Society, and to Mr. W. H. Montgomery for carrying on experiments during the writer's enforced absence, as well as for many other services.

161. In fact it was this change which introduced sufficient delay to make it possible for the young Song Sparrow to open the door. She did not, so far as could be seen, do so in an imitative way. Later there were a few movements which were similar to those of the White-throated Sparrow, but they did not have to do with the right part of the box.

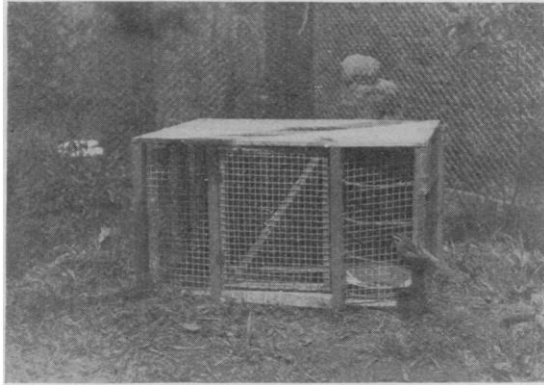


FIG. 14

This shows the method which the White-throated Sparrow used to open the door. She often was compelled to make many efforts because she alighted on the post rather than the outer end of String B,

TABLE VI

The Junco of series D, a Field Sparrow, a White-throated Sparrow and a male English Sparrow. Results of tests with the food-box.

Trial	Date	Time	Bird opening Box	Efforts by Bird opening Box and other behavior
1	6-24	10:30	Failed	
2	"	33:40	{ White-throated Sparrow }	1 White-throated Sparrow is much the largest.
3	"	5:10	Field Sparrow	7
4	"	1:30	White-throated	1
5	"	1:50	Field Sparrow	1
6	"-25	1:35	White-throated	1
7	"	:55	Junco	1
11	"-26	7:00	"	19 Strings damp. Early morning tests.
12	"	2:12	"	41 " " "
16	"	4:26	"	9 Raining.
17	"	:20	"	1
18	"	5:21	"	27 White-throated not allow Junco to come near for some time.
19	"-27	:14	"	2
43	7- 4	:10	"	1
44	"- 5	4:10	White-throated	2

TABLE VI—*Continued*

Trial	Date	Time	Bird opening Box	Efforts by Bird opening Box and other behavior.
45	7- 5	1:50	Field Sparrow	1
46	"- "	7:16	White-throated	1
47	"- 6	:40	"	1
48	"- 7	1:10	"	2
49	"- "	1:35	Field Sparrow	1
50	"- 8	3:10	White-throated	1
51	"- "	3:50	"	1
61	"-13	7:35	"	9 Junco 7 efforts.
62	"- "	4:00	Junco	4
63	"- "	10:40	White-throated	6 Junco 26 efforts.
64	"- "	3:05	Junco	12
65	"-14	19:35	Failed	Junco 21, White-throated 50, Field Sparrow 1.
66	"- "	1:20	White-throated	1
67	"- "	:25	Junco	1
70	"-15	:48	"	2 Male Eng. Sparrow in the cage. Junco on string with door open.
71	"- "	2:13	White-throated	1
72	"- "	5:50	Junco	1 Male Sparrow tried twice.
78	"-18	16:00	Failed	White-throated 22 efforts, Junco 25, Field Sparrow 1.
79	"- "	8:00	"	Raining.
80	"- "	7:40	English Sparrow	White-throated 16 efforts, Junco 11 efforts.
81	"- "	2:08	Junco	1
82	"-19	:38	White-throated	1
83	"- "	:48	"	1
84	"- "	2:11	"	2 Struck once with beak.
85	"- "	2:10	Junco	2 Junco mistook left end for front.
86	"-20	1:43	White-throated	12 efforts.
89	"- "	:45	Junco	1
90	"-22	9:30	White-throated	72
102	"-25	6:38	Junco	1 White-throated 4 efforts.
103	"- "	4:05	White-throated	3 Young Song Sparrow 10.
112	"-29	1:30	"	10 All mere passes at string. Really on post. See Fig. 14.
129	8- 3	:15	"	1 Food in left front corner. No effect.
130	"- "	2:18	"	1 Food in left rear corner. No effect.
131	"- 4	1:10	"	1 White-throated and Song Sparrow in a different cage.
132	"- 5	:45	"	1
133	"- "	1:46	"	1
134	"- "	1:20	Song Sparrow	3
135	"- "	2:19	White-throated	2 Song Sparrow 2.
136	"- 6	:35	"	1
159	"-13	2:22	"	6 Food to left of door caused some of the efforts to be on the left side.
160	"- "	1:30	"	3

TABLE VI—*Continued*

Trial	Date	Time	Bird opening Box	Efforts by Bird opening Box and other behavior.
161	8-14	1:38	{ White-throated Sparrow }	15 Food in left rear corner. Greater confusion.
162	"	1:13	Song Sparrow	3 Not in imitating way.
163	"	2:16	"	3 Song Sparrow 7.
164	"-15	3:55	White-throated	1
165	"	1:55	Song Sparrow	4 Song Sparrow 1.
166	"-16	:32	White-throated	1
167	"	1:52	"	2
168	"-23	:17	Song Sparrow	1
169	"	1:04	White-throated	1 Song Sparrow 1.
170	"-25	6:38	"	34 New box. Must jump higher for string B.
171	"	7:25	"	35
172	"-26	1:38	"	10
173	"	2:45	Song Sparrow	2 One effort by Song Sparrow might be called an imitation of White-throated.
174	"	:14	"	1
175	"-27	:30	"	2 One as in 173.
176	"	1:50	"	7 Two as in last test.
177	"-28	1:22	"	3 Successful by flying from a distance.
178	"	1:20	"	2
179	"-29	:11	"	1
180	"	1:55	"	1
181	"-30	:47	"	1
182	"	2:12	White-throated	17
183	"-31	2:50	"	5 Song Sparrow 3.
184	"	1:16	Song Sparrow	1
185	9- 1	5:32	White-throated	49 Song Sparrow 11. Many times the White-throated between strings A and B as the Bluebird.

In the 55th test the Junco mistook the end of the box for the front. I foresaw by her behavior that such was likely to happen and there was no error in the observation.

The new box used after the 169th test was a source of trouble for the White-throated Sparrow. String B was an inch or so higher than it was on the old box. She should now have jumped higher, but she did not learn readily to do so. This again was favorable to the Song Sparrow, who now opened the box until toward the close of the series.

The present series is not satisfactory from the standpoint of imitation. There are some signs of it, but they are inconclusive and do not satisfy the criterion which is adhered to in this paper. These results are interesting from the fact that new birds are tested and found to learn in a typical manner. If not so rapidly it may be due to the location of the cage and the interference of the White-throated Sparrow. She did not

learn rapidly; that is, the results for a time at least do not indicate it because of her indirect method. This method shows that she had no comprehension of the relations involved between parts of the box. The Junco probably forgot very little during the interval of half a month. It simply required a few trials to overcome the effects of the changed conditions. The effect of changed conditions is seen in the behavior of the White-throated Sparrow on the transfer of the food-pan in the strange cage.

Series F.

Tests with the Food-box on a Field Sparrow, a Junco and the male English Sparrow of the previous series after the White-throated Sparrow and Song Sparrow had been Removed.

These tests are open to the same disturbances which affected the last series. This cage was small, near the door into the building which opens into all the cages and nearest to the rear entrance of the main building. It follows that there were many disturbances.

It is to be noted that the Junco, the same as figured in series D and E, opened the door but three times during this series. The Field Sparrow seemed to get hungrier than the others. This and its greater tameness may explain why it was the bird with which we must deal in the present series.

In the 5th test the little Field Sparrow used a method similar to that used by many of the English Sparrows. This was to fly out from the upper front edge of the box, turn, and alight on one of the higher strings. Often alighting on the string did not open the door, but when she started to fly away the additional jerk she gave the string was sufficient to lift the latch. Frequently, however, this did not open the door. Very early she formed the habit of jerking the string by many flaps of the wings.

Her slight weight is the one chief cause of the fact that the times remain long and the efforts many. In general she learned as the others. As with many of my birds, though perhaps to a greater degree, she illustrates that fixity of the order of movements which they follow in the process of doing the thing learned. Her order was to fly first to a branch at the top of the cage, then to the water faucet, thence to the left end on top of the box, then to the right corner and thence off on the strings. Her conformity to this order was not without exceptions, but it was certainly striking.

TABLE VII

Really a continuation of the previous table but with only one Field Sparrow, the Junco of Series D, and the male English Sparrow in the cage.

Trial	Date	Time	Bird opening box	Efforts of bird opening the box
1	8- 4	8:47	Field Sparrow	8 This bird was very much smaller than the others.
2	" "	2: 5	"	3
3	" 5	9:50	"	10
4	" "	4:42	Junco	2
5	" 6	4:45	Field Sparrow	7 Flew out from top of box turned and alighted on string.
6	" "	2:35	"	4
7	" "	3:35	"	2
8	" "	5:10	"	3
9	" 7	5:40	"	15 She was not heavy enough.
10	" "	9:40	"	1
11	" 8	5:59	"	2
12	" "	1:12	"	2
13	" 9	4:37	"	12
14	" "	:30	"	1
15	" "	2:28	"	4
16	" 10	4:16	"	2
17	" "	4:38	"	1
18	" "	1:50	"	6
19	" "	9:10	Junco	1
20	" 11	1:10	Field Sparrow	3
21	" "	1:06	"	4
22	" 12	1:29	"	2
23	" "	:50	"	3
24	" 13	:53	"	4
25	" "	:33	"	3
26	" 14	:14	"	2
27	" "	1:28	"	4
28	" "	:42	"	3
29	" 15	:12	"	1
30	" "	1:	"	2
31	" 16	:50	"	2
32	" "	1:40	"	1
33	" 17	:13	"	5
34	" 23	2:23	"	3
35	" 25	1:	"	4
36	" 26	:40	"	6
37	" "	:22	"	1
38	" 28	2:10	"	3
39	" 30	:30	"	2
40	" "	:17	Junco	1
41	" 31	1:48	Field Sparrow	2
42	9- 1	:19	"	

Series G.

Result of Tests with the Food-box on a pair of Bluebirds and White-crowned Sparrows; also two of each of the following named species,—Juncos, and Song, Tree, and Fox Sparrows.

There were probably for the best results too many birds in

this cage. There is apt to be too much fighting and it is impossible to keep a satisfactory record of all that is done by the different birds. The chief cause for having so many was that all the other cages were occupied by birds engaged in mating or in rearing young. Indeed it was later learned that these Bluebirds were so engaged. This fact may partly explain why they came to be masters of the situation in this instance.

It is interesting to note that it is the best fighters here, as in a series earlier described, which first open the box. However, this does not mean that they continue to hold first place throughout the series.

The Bluebirds exhibited that characteristic timidity which may be seen in a little observation out of doors. They never attacked the other birds and strictly minded their own business. Many times they were compelled to beat a hasty retreat by the Tree, White-crowned, or Song Sparrows.

If what one may observe in a wire cage of this size (ten feet square by six feet high) of the insect-catching habits of these birds is any criterion, the Bluebirds far outclass any of the others. They gave abundant evidence of being able to see small insects when at least some six to eight feet distant and, of course, lost no time going after them.

From the accompanying table it may be seen that there is much alternation at first. The Bluebirds are not much in evidence until the 6th test when the male opened the door, the female being successful on the 7th test. This looked like imitation and yet as she had no previous method it cannot be said that she was following the example set by the male in what she did. For the present it is probably best to regard their behavior as similar responses to the same situation, with a strong tendency in these Bluebirds to follow each other rather than any of the birds of the other species. The Bluebirds were the rightful owners of this cage. The other birds were turned in only a few days before the tests were begun.

TABLE VIII

Results of tests with Food-box on a pair of Bluebirds and White-crowned Sparrows; also two each of Tree, Song and Fox Sparrows; also two Juncos.

Trial	Date	Time	Bird opening Box	Efforts by Bird opening Box and other behavior
1	6-15	4:50	Tree Sparrow	11 Stepped on string. Tree Sparrow was a good fighter.
2	" "	5:45	{ White-crowned Sparrow }	4 White-crowned Sparrow stepped on string was a good fighter.
3	" "	3:	"	3
4	" "	20:45	Tree Sparrow	2

TABLE VIII—*Continued*

Trial	Date	Time	Bird opening Box	Efforts by Bird opening Box and other behavior.
5	6-15	7:25	Tree Sparrow	4
6	"	3:	Male Bluebird	2 By alighting on strings.
7	"	1:25	Female "	2 " " "
8	"	:40	Tree Sparrow	2
9	"	:25	"	1
10	"-16	1:05	Female Bluebird	1
11	"	5:55	Male "	2
12	"	5:25	"	5
13	"	:20	Female "	1
14	"	9:05	Tree Sparrow	1 Female Bluebird many ef- forts.
15	"	7:20	"	1
16	"	1:05	Fox Sparrow	1
17	"	4:40	M. White-crowned	1
18	"-17	8:	"	1
19	"	1:30	Song Sparrow	3
20	"	4:20	"	2
21	"	2:35	Male Bluebird	2
22	"	4:55	Fox Sparrow	1
23	"	2:38	Male Bluebird	2
24	"	9:35	Tree Sparrow	2
25	"	1:	M. White-crowned	1
26	"	12:55	Male Bluebird	4
27	"	2:45	"	2
28	"	2:05	F. White-crowned	1
29	"	2:40	Tree Sparrow	5
30	"-18	17:47	Male Bluebird	1 Early morn'g tests, strings damp, and pull hard.
31	"-18	23:10	Tree Sparrow	8
32	"-19	:20	" "	
33	"	1:	Junco	
34	"	:40	Male Bluebird	
35	"	:40	Female "	
36	"	:50	Male "	
37	"-20	:50	" "	
38	"	1:35	Fox Sparrow	
39	"	:05	Male Bluebird	
40	"	2:15	Tree Sparrow	
41	"-21	8:35	Male Bluebird	
42	"	2:25	White-crowned	
43	"-22	1:30	Tree Sparrow	
44	"	1:15	Male Bluebird	
45	"	18:30	Fox Sparrow	
46	"-23	2:10	Tree "	5
47	"-24	:55	Male Bluebird	1
48	"	3:30	Female "	1 From perch to string as male Bluebird often did.
62	"-26	6:11	Male "	1
63	"	2:27	Song Sparrow	1
64	"	6:35	Male Bluebird	4
141	7-17	:13	" "	3

Much the same succession followed in the 11th test for the male, who opened the door in the same manner as the female had

just done. In the 35th, the 48th and the 55th tests she opened the door in much the same manner as both had done previously. According to my notes the correspondence between the behavior of these two birds is close, but there is little proof that one changes its behavior because of the example set by the other. Fig. 15.

At about the 47th test the male Bluebird began regularly to open the door. The table is not carried farther than the 64th test for the reason that nothing except a lowering of the time and number of efforts occurs. There is little necessity then for a tabular statement of the remainder of the 141 tests. It should be added that the number of efforts by the male Bluebird is often greater than would be expected. An explanation for this may be found when we see what occurred in the Memory series which were made after one month had elapsed.

Memory Tests

For these tests the Bluebirds were alone and in a smaller cage. They were placed here sometime prior to the beginning of this series. From any of the results, or an average of the entire number, it may be seen that they have by no means lost all the training due to their earlier experiences with this box. Their average time is perhaps three or four times what it was at the close of the initial series. Barring disturbing factors in both the initial and first part of the memory series the number of efforts required is about the same. It is probable

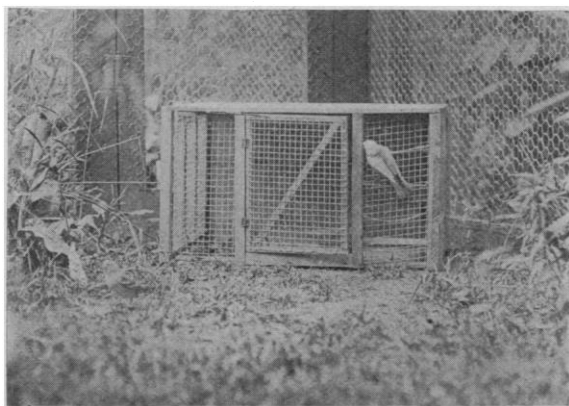


FIG. 15

The male Bluebird in characteristic position to open the door. A white-crowned Sparrow in front and to the left.

that the changed conditions cause the time to be longer. In fact it was noted at the time that such was the case.

Aside from showing how well they remember, this memory series shows some very interesting happenings. How they remember is even more significant. For the 5th test I inadvertently placed the food-pan behind the door instead of just inside the wire from the niche where the strings were placed. The male Bluebird at once made six trials on the door where there were no strings. I then interrupted long enough to place the food-pan in its old place and he immediately alighted on the wire between the strings. Are we then to infer that he has been primarily alighting in a certain place and rather as an accompaniment of this place association he has through no definite intent of his been pushing the strings in or down and opening the door? The greater number of efforts than we should expect in the last part of the initial test series belongs with this sort of association and really should have prepared us for the fact just mentioned.

TABLE IX

Memory tests for Bluebirds. One month interval.

Trial	Date	Time	Bird opening Box	Efforts of Bird opening Box and other behavior
1	8-17	:30	Male Bluebird	1
2	" "	:25	" "	1
3	"-18	:20	" "	1
4	"-23	:20	" "	1
5	"-24		" "	6 Food-pan placed just behind door. Male Bluebird made 5 efforts. Food pan then placed behind strings. One effort there opened door.
6	"-25	:13	" "	1
7	" "	:46	" "	4 A new box with strings A and B slightly wider apart. Many times to the wire without touching strings.
8	"-26	1:12	" "	7
9	" "	:25	" "	4
10	" "	:30	" "	3
11	"-27	1:08	Female "	1
12	" "	:55	Male "	7
13	"-28	:30	" "	5
14	" "	1:13	" "	5
15	"-29	:48	" "	4
16	" "	:28	" "	6
17	"-30	1:13	" "	6
18	" "	:16	" "	1
19	"-31	:25	" "	1
20	" "	:30	" "	3
21	9- 1	:20	" "	1

In conjunction with the next observation to be related and many other facts concerning the kinds of error made by birds of other species, it would seem possible to throw some additional light on the extent to which these birds really analyze the situation which confronts them.

For the sixth test of this Memory series another box to be opened was used. This new box had to be used with the Bluebirds, Field Sparrows, and White-throated Sparrow, in order that I might change the fastening on the old box and use it with the Baltimore Orioles and Blue Jays. The new box was identical with the old except that a slightly wider space was left between strings A and B.

The number of efforts required for the male Bluebird to open the box at once increased. It was easily observed that he alighted on the wire between strings A and B. Ostensibly his trials were more numerous for the reason that there was now greater space here and he could hop on the wire without striking the strings. If this is true then what is good from the standpoint of Memory alone need not signify much when we inquire as to the degree of analysis of which this bird is capable. We get a suggestion from this of how lacking in real analysis any act of bare recollection may be. These strings have not meant and never could mean to him at all what they mean to human consciousness. It was not for him the strings to pull, but a place to alight; more correctly perhaps he just alighted. Even saying no more than that it was a place to alight is putting it too anthropomorphically. True the bird is intelligent, but his consciousness must be far more simple, vague and unanalytic than our own.

Imitation is not clearly shown in this Memory series. The female does at times make trials at the same time with the male or follow him closely. But as in so many other series of tests, the writer feels that his criterion has not been met in a satisfactory way.

Series H.

Tests with Food-box on a Pair of Blue Jays.

The results obtained from a long series of tests with these birds is doubly interesting for the reason that this pair of Jays was reared by hand. They were very tame, or soon became so. Often they alighted on my back while I was placing the box in the cage. If at all hungry the male had to be carefully watched or he would alight on top of the box and take food from the pan as the box was carried into the cage.

These Jays, particularly the male, were very musical. It is said that much of it comes from the imitation of musical instruments like the mandolin, guitar and violin, all which they

have had opportunity to hear. However uncertain this may be, I have never heard such notes by Jays in their natural haunts. I doubt if many other birds can surpass such low, sweet, metallic notes which they were wont to put together in the most pleasing way.

The Jay, like the Crow and English Sparrow, is popularly considered as a very intelligent bird. As with the Crow, it was to be expected that they would use the beak on the strings, Fig. 16. This they did throughout, making only a few attempts to open with the claws or hop up on the box as the smaller birds do most frequently.

The beginning tests, as may be noted, if the reader will refer to the table below, are of the same general kind which have been found for all smaller birds. This is true, particularly of all those which are compelled to open the door without any example by another bird which may serve as a model to be imitated, or what is probably more often the case, as only of general suggestive value which calls into play nothing more than what may be designated as the following instinct.

It should be said that because of lack of time these Jays were not allowed to eat from the box previous to the first tests and thus get accustomed to obtaining their food from it. This, of course, might have affected the first few results, but only these.



FIG. 16

The male Blue Jay is in the act of opening the door by pulling the knot on String B. In test 110 (Table X), though the strings had been changed to the left of the door, this bird persisted in opening the door by reaching through the wire and pulling up the latch.

TABLE X
Test with Food-box on Blue Jays.

Trial	Date	Time	Bird opening Box	Efforts of Bird opening Box and other behavior
1	7-15	30:	Failed	
2	"	1:35	Male Jay	
3	"	1:05	"	1 Chased away female
4	"	:20	"	
5	"-16	20:22	"	32 Female many efforts also.
6	"	1:35	"	10
7	"	2:13	"	29
8	"	7:08	"	51 He did not allow her to come near the box.
9	"	3:37	"	5
10	"-17	15:	Failed	Not very hungry.
11	"-18	15:	"	8 efforts by female.
12	"	4:25	Female Jay	1 In same way as male. The only sign of imitation in the series.
13	"	:35	Male Jay	1
14	"	1:20	"	1
15	"	2:22	"	11 Most of these incorrectly placed.
16	"-19	1:32	"	2
17	"	1:13	"	3
18	"	:48	"	1
19	"	3:10	"	7
20	"	1:08	"	6
21	"	3:13	"	3
22	"-20	1:30	"	6
23	"	:30	"	1
24	"	2:25	"	8
25	"	:47	"	3
26	"-21	:20	"	1
27	"	:47	"	1
28	"	:18	"	1
29	"	:12	"	1
30	"	:17	"	2
31	"-22	:16	"	1
32	"	:17	"	1
33	"	:25	"	1
34	"	:24	"	1
35	"	:35	"	4
36	"-23	:12	"	1
37	"	:18	"	1
38	"	:20	"	1
39	"	:18	"	1
40	"	:08	"	1
41	"	:27	"	2
42	"	:08	"	1 Returned twice to pull the string five times with door already open.
43	"-24	:12	"	1
112	8-25	:05	"	11 Strings to left of door but opened through wire at old place. Five pulls after door opened.

TABLE X—*Continued*

Trial	Date	Time	Bird opening Box	Efforts of Bird opening Box and other behavior.
113	8-26	:20	Male Jay	2
114	" "	:10	"	2 Two efforts on the strings to the left of the door but finally used old method in all the remaining trials.
115	" "	:02	"	1
116	" "	1:08	"	9
117	"-28	:10	"	1
125	9- 1	:25	"	6

Some of the extremely long times early in this series may also be due to the same fact that had to be kept in mind with the Crows. The Jays also store away their over-supply of food and they may not have been as hungry as one would infer from the period of time since they were last fed.

Knowing the use which the Blue Jay makes of his beak in the opening of nuts, etc., it was not surprising that he should use the same method as the Redheaded Woodpecker and the Crows were found to do in such a vigorous and persistent manner.

The female Jay showed very little tendency to imitate. She opened the door but once and this in the 13th test, though my notes several times make record of the fact that she might have done so if opportunity were all that was needed. It should be said, however, that during the first tests she really had little opportunity. The male was certainly a tyrant in this family. The female, as a rule, never entered the box to eat until the male had satisfied his hunger and left. Not being allowed near the box at the start, she formed the habit of staying away, and this is directly inimical to imitation in later trials. She followed him to the box often, however, as indeed all the birds have done with each other.

In the 43rd trial the male for some reason left the box after taking only a few bits of food. He soon returned and, with the door already open, pulled the string three times. He then went to the top of the box, but did the same thing twice more on his next approach. In the 112th trial he again repeated the same action under exactly similar conditions five times. He did, therefore, what the other birds, most of them, have been seen to do.

By the 60th trial this Jay has probably learned to open this box as readily and easily as he ever will. The table, therefore, omits the results of tests 44 to 58 and 60 to 109 inclusive.

For the 110th test the strings were transferred to the left of the door. The Jay struck twice on place 1, then hopped up on the wire at the same place, then twice on the strings in

their new position, place 2, and lastly seven in place 1 where he succeeded by reaching through the wire in the old place and pulling up the latch. But once during the remainder of fifteen trials did he make use of the strings. It is evident from the number of efforts during these final tests that it is the place which is firmly fixed, or associated, for he will make a great many efforts through the wire on the thread or projecting end of the latch rather than work on the strings. These, too, have only been changed to the left of the door and they are very conspicuous.

We get, then, from this series proof of the ability of the Blue Jay to learn. This he may do somewhat more rapidly than some other birds, but really in very much the same way. As proof of imitation we get very little as compared with some of the other groups of birds. But in these instances there would seem to be that which one may sometimes get from negative results. This male Jay had no rival, he was not as cautious as the Old Crow and the male English Sparrow, and there were no long intervals of waiting as with the latter and the Cowbird.

Series I.

Tests with Food-box on two male Baltimore Orioles, three Cowbirds,—two males and one female,—and two young English Sparrows.

At the beginning of the present series there was but one male Oriole present. The young English Sparrows, though they were partly reared by hand, were so wild that they did not approach the food-box at all in the early tests. It is true they could not be expected to cope successfully with the mature birds of the larger species, and yet if at all hungry they could at times take care of themselves surprisingly well.

During the first four trials, and once following this, one of the male Cowbirds opened the door. In this series these initial times are relatively short. This is probably due to the fact that the strings were rather easily worked and the birds rather hungrier than in some of the other series. The Cowbird's method was one somewhat peculiar to this bird, though not entirely so. He lifted one foot and clawed the lower strings. In the second test he must first fight off the Oriole. Close observation showed that the latter might be outclassed as a fighter, but would not necessarily be driven off. He would open his mouth, express his emotional state in rapidly succeeding cries, fall back on his haunches, and stand his ground. In the 4th trial the same Cowbird changed his method and used his beak on the string.

In the 5th test the Oriole took his turn, but in an obviously

accidental manner. It is, of course, understood that all these first successes are accidental. In this case it will be easily seen it was if possible more so. In flying to the top on the front side of the box the Oriole slipped off and struck the top-most string. He succeeded in the next trial by using his foot on the lower string. The 7th trial required an inordinately long time and his final method is far removed from the simplest way in which the door may be opened. What he did was to put the beak through the wire and pull the black threads which run vertically from the latch in order that they may be attached to the outside strings. A most indirect method, one which

TABLE XI

Tests with Food-box on two male Baltimore Orioles, three Cowbirds and two young English Sparrows.

Trial	Date	Time	Bird opening Box	Efforts by bird opening Box and other behavior
1	7-21	:40	Male Cowbird	By stepping on lowest string.
2	"	3:55	" "	By stepping on lowest string. Oriole 1 must be driven away.
3	"	6:15	" "	By stepping on lowest string. Oriole 1 must be driven away.
4	"-22	5:28	" "	7 Pecked at each end of latch. Cowbirds afraid. One eye turned toward sky.
5	"	5:20	Oriole 1	Struck top string in going to top of box. Young English Sparrows very wild though reared by hand.
6	"	1:50	"	By foot on string.
7	"	8:38	"	By beak through wire mesh on threads. Oriole 1 chased Cowbird away.
10	"-23	23:58	"	24 Cowbird chased away nine times.
11	"	5: 3	"	14 Cowbirds not down.
12	"	4:15	"	14 Oriole opened by pulling knot on lowest string.
13	"	1:55	"	1
14	"-24	3:43	Cowbird	3 In same way as he did in 4 above. Oriole 1 made two efforts through wire at threads.
15	"	4:40	Oriole 1	7 Oriole 1 opened through wire.
18	"	1:28	"	10 9 of which were on threads with beak
30	"-29	1:	"	13 Oriole opened by working string B on outside.
31	"	:20	"	1 Returned to old method.

TABLE XI—*Continued*

Trial	Date	Time	Bird opening Box	Efforts by bird opening Box and other behavior.
40	8- 1	:47	Oriole 1	41 Oriole finally opened by striking outer string B.
41	" "	:52	"	4 Beak on end of latch.
48	" 4	:57	"	3 A second male Oriole in cage. He was clearly master. Made many efforts.
49	" 5	:23	"	3
50	" "	:12	"	1
51	" "	1:10	"	2 Oriole 2 much in the way. O. 2 after O. 1 has entered made some 10 efforts very like those of O. 1.
52	" 6	:28	"	3
53	" "	1:25	"	3 O. 2 entered first. O. 1 pulled strings 4 times with door open and O. 2 inside.
54	" "	:27	"	1 O. 1 pulled strings 3 times with door open.
55	" "	:15	Oriole 2	By standing on string 1 and striking on 2.
56	" 7	:47	"	By striking. O. 1 driven away just as he was opening door.
57	" "	1:	" 1	In his old way.
58	" "	2:	" 2	By flying on string D. O. 1 driven away.
59	" 7	:51	" 2	By flying up on string D.
63	" 8	:48	" 2	By accident. O. 2 slipped off post and struck string C.
64	" "	:12	" 1	In his old way. O. 2 followed up the accident of last time and missed.
65	" 9	:15	" 1	In his old way Same as before.
66	" "	:41	" 2	5 All at strings C and D.
67	" 10	2:02	" 2	6 Many of these efforts were made by following up the accident.
68	" "	:04	" 2	1 on string D.
69	" "	:33	" 2	5 went to post, thence to string D.
72	" 11	4:12	" 1	O. 1, 15 trials. O. 2 8. Something wrong with box. O. 1 opened in old way but went to post once as O. 2 did often.
73	" "	:27	" 1	O. 2 was clinging to door when it opened.
74	" "	3:45	" 2	6 O. 2 to post once and on door 5 times. O. 2 to string C from door.

TABLE XI—*Continued*

Trial	Date	Time	Bird opening Box		Efforts by bird opening box and other behavior.
76	8-12	:23	Oriole	2	5 efforts, 4 on door.
77	" "	:03	"	2	From ground to string C.
83	"-15	:05	"	2	O. 2 from door to string C.
89	"-25	:20	"	1	Strings changed. Opened in old way. O. 1 followed O. 2 on door.
90	"-25	:30	"	1	O. 1 in old way. O. 1 again follows O. 2 to where string should be.
91	"-26	:15	"	1	O. 2 made many trials.
92	" "	:15	"	1	O. 2 made many trials. O. 1 made two efforts like O. 2.
93	" "	:03	"	1	2 efforts in old way.
94	" "	:15	"	1	3 efforts in old way.
95	" "	:15	"	1	15 in old way.
101	"-29	:05	"	2	1 on string C.
102	" "	:25	"	1	3 O. 2 made 1 effort on left of door.
103	"-30	:28	"	1	11 efforts. O. 2 made 1 effort on left of door.
104	"-30	:10	"	1	5 Some tendency in O. 2 to use bill.
105	"-31	:05	"	1	2 O. 2 to left of door.
106	" "	:07	"	1	1 O. 1 showed tendency to follow O. 2.
109	9- 1	:08	"	1	1

we shall later find the Crows using, and a method that may give the experimenter both positive and negative results for which he has not reckoned.

By the 9th trial the Oriole constantly chased the Cow-birds away from the box. On the 14th test the same male Cow-bird opened the door with the beak on the end of the latch by reaching through the wire mesh. As he did this but once it can hardly be counted as a good example of imitation.

For the 48th and succeeding trials the second male Oriole was placed in the cage. It was evident at once that he was more pugnacious than Oriole 1. There was no doubt that he would be ruler of this cage in a short time. He made efforts to get into the food-box during this his first trial. Three tests later, after Oriole 1 had opened the door in his usual manner (by reaching the beak through the wire mesh and pulling threads), the behavior of Oriole 2 was most significant. He made many of the same kind of efforts as Oriole 1 had just made but the latter was inside eating and the door was open.

Oriole 1 continued to open the door for three more trials. In the 53rd Oriole 2 entered first and Oriole 1 pulled the threads fourteen times with the door standing open. In the following

test he did the same thing four times under similar conditions.

There now began that period of alternation which has happened in previous series in which first one then the other was successful. The first method of Oriole 2 was to stand on the lower string and strike the one just above. Several times Oriole 1 was chased away just as he was on the point of pulling the threads. In the following trials Oriole 2 was successful by flying up on strings near the top. It is evident that if he did imitate it was not for long. Flying up and pushing the top string is certainly not an imitation of Oriole 1 in his reaching through and pulling the threads. The number of efforts required of Oriole 2 at this stage would indicate that he had not yet singled out the single part and only that which must be worked.

The 62d test gave interesting proof of the statement just made. Oriole 2 alighted on the post just above the outer end of string C. In an apparently accidental manner he slipped from the post and struck this string and the door opened. Would he use this method in the following trials? I was watching for him with camera focused and the accompanying figure, 17, was the result. His erroneous association and the efforts which he made to operate the strings by merely alighting on this post was what allowed Oriole 1 to step in and be successful during the following two trials. This, too, in face of the fact that Oriole 2 was the first at the box. In the later trials the latter would often go to the post and thence up to the top string.

Usually in learning tests with animals it is unfortunate if the fastenings of the food-box fail to work as easily or in the same way as they have in the past. Yet as we shall see directly for these Orioles and later for the Crows, such an accident in tests on imitation is really a favorable occurrence. Reference to Table XI will show that the time is greatly lengthened for the 70th and 72d tests. It was evident that there was something wrong with the box. Oriole 1 was successful only after fifteen attempts, all save one of these being on the threads. Oriole 2 made eight attempts at hopping on the post and Oriole 1 made one such attempt. Apparently in imitation of Oriole 2, and in a very sudden and impulsive manner. In the 71st trial Oriole 1 opened while at the same time Oriole 2 was hanging to the door. What was the effect of this in the next trial? The length of time in this next trial is due partly to the fact that Oriole 2 must hop on the door five times. In fact he left the door to go directly to string C, Fig. 18. Again something entirely unnecessary becomes to this bird an important link in the association series because his hopping on

the door was simultaneous with the pulling of the thread by Oriole 1.

For the 87th test the strings were removed from the right and placed in the niche to the left of the door, place 2, Fig. 19. Oriole 2 was on the door and went thence to where string C used to be. Oriole 1 opened in his usual way by pulling the threads. In changing the outside strings to the left of the door I had, of course, intended to modify the box for Oriole 2. At any rate if we failed to get results on the readiness with which Oriole 2 could do as the female English Sparrow did in series A, we did get some slight indications of imitation of Oriole 2 by Oriole 1. It was very similar to the result obtained a little earlier in this series. In the following test there was likewise a single indication of imitation.



FIG. 17

Male Baltimore Oriole 2. He, during an earlier trial, flew to this post, slipped off, struck String C and opened the door. He is shown here continuing this wholly unnecessary action.

For the remainder of this series Oriole 1 continued to open the door. Oriole 2 to all appearances saw him, but as they began to moult badly I did not improve the mechanism as I did later for the Crows in order to compel just one method of gaining entrance to the box. It is probable that these Orioles, had the tests been continued, would have given much better evidence of the power of imitation.

Great interest naturally attaches itself to these tests for the reason that at least one popular writer on the Baltimore Oriole has found it capable of very remarkable performances. It is said to resort to measures distinctive of an adult human being in arranging supports for its nests and in the tying of knots in

strings used for such supports. Indeed many human beings would be incapable of what was reported of this pair of Golden Robins.



FIG. 18

Male Baltimore Oriole 2 as he came to open the door after many other attempts.

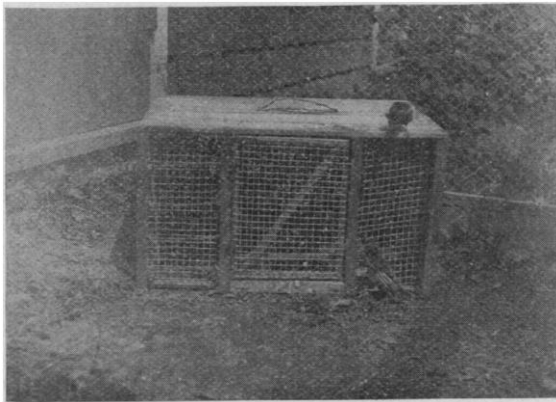


FIG. 19

The strings are to the left of the door, Place 2. Male Baltimore Oriole 2, instead of working the strings in the new position, tried the old place, failed, and was here watching Oriole 1 reach through the wire as the latter was accustomed to do earlier.

The writer has been much interested in the many abortive attempts of pairs of Baltimore Orioles to build their nest in the

cages of the aviary where the above tests were made. When supplied with much material which they may naturally be expected to use, all their nests are imperfect, some much more so than others. It may be seen that in all of them an attempt is made to adhere pretty closely to the nest so typical of this species so many of which are found on the slender elm branches over our streets and sidewalks. Not a single observation on many such imperfect nests for a number of years would go far to corroborate the above remarkable findings with respect to nest building. Such astonishing results would for their satisfactory explanation require reasoning in these Orioles. The present pertinent query is,—Did the two male Orioles who were submitted to all the above tests show any signs of any mental power above that of intelligence or the "trial and success" method of learning? It should be said in this connection that to infer from an isolated single instance that any animal reasons or does not reason is a method hardly to be tolerated in our present science of Animal Behavior. In fact, the study of human reason requires a series of tests with the same problem or situation from day to day.

In the above tests it is clearly evident that each bird, the male Cowbird, then Oriole 1 and lastly Oriole 2, first learned by accident how to operate the fastenings and in his own way. Even after Oriole 2 had done the right thing for a number of times a little accident led him astray. In so far as there is imitation it is shown by Oriole 1 when he copied certain actions of Oriole 2 which were never calculated to bring any results. They were errors on the part of the latter. As such they were imitated very suddenly and impulsively. Such imitation could hardly be rational or reflective. Intelligent it may be. Again, if there is any reasoning in all this ought not Oriole 2 have opened the door when the strings were changed from the right to the left side? He had worked the strings on the right side but twenty-six times all told. He certainly could not have formed so fixed a habit that all his power to reason, if he had any, was made as if it were not by habit. Truly these Orioles fall into the same class with all other animals which have been subjected to careful continuous investigation which exhibits to us the origin and development of the learning process. They learn gradually to perform just that act which rather directly brings the pleasurable result. The writer does not know of any series of experiments which are better calculated than these with the Orioles to illustrate the direct following up of acts which by merest accidents brought the bird to the food. Such, it seems to me, is the correct interpretation to place upon the results embodied in the present section of this paper.

Series J.

Intelligence and Imitation in Crows as Determined by Tests in Opening the Food-box.

The old Crow, Jim, with which my first work on Crows began had been in possession of Mr. Worthington for some five or six years. His wings had been clipped and most of the time he was to be found in some part of the large lawn. For a year or more he had been confined to a large wire cage. He was very wary. Even an acquaintance must exercise care in pulling Jim's beak or scratching his head for at such times he was apt to use his bill with painful results.

It should be added that the sex of this bird as well as that of the young crows was not known. If they are referred to as males it is only in an impersonal way and analogous to what we do with many other animals as well as inanimate objects.

On rare occasions Jim could be induced to swell himself up very much and apparently with the greatest effort give utterance to something which sounded like a muffled "Hello." The presence of ladies seemed to furnish a stimulus better calculated to call forth this one expression—Jim's whole vocabulary. I could more frequently induce him to imitate me in saying this word by having a white towel in my hand. It seemed to me that the ladies wearing white could best get Jim to show off his one accomplishment.

As remarked above Jim was most cautious and wary. Any new object placed in his cage he was most slow to make use of. How then was I to determine how rapidly he could learn to open my food-box. I began with him somewhat gradually. On the twelfth of June I made a box like that shown in Fig. 21. To begin with I left off the door as well as the wire from the left end and front of the box. Would Jim eat from the pan placed just inside the door? Not a bit of it. When his food supply was abundant he always hid all that he could not eat. It was hardly ever possible, therefore, to know exactly when you had cut off his supply. Yet in this case I had to coax him nearer and nearer the box by placing the pan well in front and by degrees nearer. Finally I starved him into approaching near enough to stand on tip-toe, stretch his neck, and very suddenly take a bit of food from the pan inside. As an extra inducement I often placed in the pan half a hen's egg of which he seemed to be very fond. With each addition of wire, door, or strings he had to be given time to overcome a new lot of caution.

On July twenty-fourth, about six weeks after I first placed the box inside the cage, my first test was made. The box with door closed was placed in at 2.31 P. M. After forty trials, which

he began to make after the box had been in about two hours, he opened the box by pulling the second string with his beak. Most of his trials were pecks on the wire eyelets by which the strings were attached to the post at the right corner. It was most amusing to see him peck at these and the wire and then in a savage manner pull up great bunches of grass. After the door was opened seven minutes were required for him to take a bit of food from the pan just inside the door.

On the 2d test seven minutes were required and twenty-nine efforts. The 3rd and 4th tests were failures for the reason, largely, that he was not hungry enough. The cause of this was that he had stolen a rat from the caretaker while the latter was feeding the Sparrow-hawk.

From the accompanying table (XII) it may be seen that this Crow like the other birds learned rapidly once he began. He was given more trials per day than most of the others. His many efforts were perhaps due to the fact that his fright caused him to attempt to strike when he was too far off to do so accurately.

On the 20th test he returned to the perch at once on opening the door. Almost immediately he returned to pull the first string some nine times and this with the door already open. On the preceding day he did this once as I started to remove the box from the cage. On the following day, July 30th, he did it four times during one trial. On July 31st,

TABLE XII

Results of experiments on three Crows with a Food-box similar to that used in all the Previous Series.

Trial	Date	Time	Bird opening door	Efforts of Bird opening door and other behavior
1	7-24	34:	Old Crow	40 made first effort after 2 hours. By pulling string B with beak.
2	"-25	7:	"	29
3	"-25	56:	"	94 Failed.
4	"-26	34:	"	3 "
5	"-26	:15	"	3
6	"-27	15:30	"	50
7	"-27	:30	"	6 Most on box and wire.
8	"-27	:30	"	25 Struck at wire eyelets.
9	"-27	1:	"	23 Too frightened to pull hard enough.
18	"-29	:15	"	9 Pulled string with door already open.
19	"-29	:10	"	5
20	"-29	:13	"	4
21	"-29	:13	"	5 Efforts now confined to string E.
22	"-30	:17	"	4 Returned twice and pulled string five times with door open.

TABLE XII—*Continued*

Trial	Date	Time	Bird opening door	Efforts of Bird opening door and other behavior.
23	7-30	:05	Old Crow	2
30	"-31	:40	"	4 Pulled string twice with door open.
33	"-	:05	"	2 Pulled string twice with door open.
39	8- 1	:05	"	1 Pulled so viciously that string came off.
51	"- 3	:08	"	1 Again pulled string with door open.
52	"- 4	:12	"	2 Young Crow 1 in with old Crow from this on.
53	"-	:09	"	1
54	"-	:10	"	1 Young Crow cautious though reared by hand.
60	"- 5	:10	"	1 Food in left front corner. Change was noted but no effect on behavior.
61	"-	:06	"	1 " " " "
62	"-	:04	"	1 Food now in left rear corner. No effect.
65	"- 6	:07	"	1 Pulled string with door open six times. Young Crow made first efforts.
66	"-	:05	"	1 Pulled string with door open.
69	"-	17:35	Failed	7 String now to left of door.
70	"- 7	10:	"	15 Young Crow 1 to top of box several times.
71	"-	10:	"	3 Young Crow played a great deal with all parts of box.
72	"-	4:25	Young Crow 1	1 By accident. Old Crow 3 efforts.
73	"-	5:45	Old Crow	1 effort to left of door. 38 efforts on old side.
74	"- 8	11:20	"	1 to left of door. 17 on old side.
75	"-	1.32	"	3 All efforts correctly placed to left of door.
76	"-	4:15	"	16 " " " "
81	"- 9	1:17	"	2 correctly placed. 11 on old side.
84	"-10	6:03	"	1 Camera in position disturbed him.
85	"-10	7:05	"	1 A painted turtle that had opened the box twice tried again.
110	"-23	2:20	Young Crow 1	3 Pulled top string from top of box. A five day interval between tests.
111	"-	1:	Old Crow	1
112	"-	1:50	Young Crow 1	1 Many pulls on the rubber band.
113	"-24	:05	Old Crow	1

TABLE XII—*Continued*

Trial	Date	Time	Bird opening door	Efforts of Bird opening door and other behavior.
114	8-24	:20	Old Crow	2 Strings to left end just round the corner. No efforts by Old Crow in old place.
118	"-25	:40	Young Crow 1	
119	"-"	:50	"	1 Old Crow struck and missed when young Crow pulled same string. Young Crow closes door often by swinging on it.
120	"-26	:15	Old Crow	1
121	"-"	:55	Young Crow 1	Many efforts all over box. He never ate out of pan. Always waited until I fed him.
122	"-"	:10	Both	Both struck at same time.
123	"-"	:06	Old Crow	1
124	"-"	1:25	Young Crow 1	6
125	"-27	:07	Old Crow	1
126	"-28	:05	"	1
127	"-"	:46	Young Crow 1	
128	"-"	:05	Old Crow	1
129	"-29	:05	Young Crow 1	
130	"-"	:52	"	Old Crow one effort when young Crow 1 came and opened.
131	"-"	:15	Old Crow	1
132	"-30	:30	Young Crow 1	1
133	"-"	1:55	"	3 efforts by Old when Young opened.
134	"-"	:10	"	From ground as Old Crow.
135	"-31	:08	Old Crow	1
136	"-"	2:04	"	2 Strings to rear corner of left end.
137	9- 1	:45	Young Crow 1	1 He searched first for strings in old place.
138	"-"	2:	"	25 Old Crow struck once in 3rd place.
139	"- 2	1:18	"	12 Old Crow 3 in second place.
140	"-"	1:30	Young Crow 2	Many efforts. Continued to pull after door opened.
141	"- 3	7:15	Young Crow 1	Old Crow made 62 efforts. most on door. Very like Young Crow 1
142	"-"	:45	" 2	3
143	"- 4	6:20	Failed	Old Crow struck 17 times at door and rubber band.
144	"-"	:20	Young Crow 2	
145	"- 5	5:30	Old Crow	2 Raining.
146	"-"	1:	"	2 Efforts at door.
147	"-"	:45	"	
148	"- 6	:12	Young Crow 1	
154	"-"	:10	Old Crow	1
155	"- 7	:06	Young Crow 1	
158	"-"	:15	Old Crow	1

TABLE XII—*Continued*

Trial	Date	Time	Bird opening door	Efforts of bird opening door and other behavior.
159	9- 8	:10	Old Crow	1 Young Crow 1 pulled string at once after Old Crow had opened.
160	" "	1:16	Young Crow 1	
161	" "	:13	Old Crow	2
163	" "	: 1	Young Crow 1	11
165	" 9	:06	Old Crow	1
168	" "	:30	Young Crow 1	
169	" "	3:25	"	1 Frightened by wire and posts which replaced boards on rear side.
170	" "	:50	"	
171	" "	:25	"	
172	" "	:15	Old Crow	1 Strings to rear side right corner for next test.
173	" "	:50	Young Crow 1	6 By pushing bill through front side. Old Crow strongly inclined to work on left side.
174	" "	1:30	Old Crow	33 He struck as Young Crow in previous trials and opened in same manner.
175	" "	1:40	"	2 hard blows on door.
176	" "	3:30	Young Crow 1	Lifted door up with claws. Old Crow made 15 efforts in front.
177	" 10	3:	"	Lifted door up with claws. Old Crow 30 efforts in front.
178	" "	3:50	"	1 correctly placed. Many otherwise.
179	" "	1:30	"	By striking through wire at end of latch. Old Crow 15 efforts in front.
180	" "	1:05	"	Correctly placed.
181	" "	2:	"	Many efforts in front.
199	" 15	1:30	"	1 Young Crow is fed and old allowed to get hungry. Old Crow made one attempt but failed.
200	" "	:50	Old Crow	1 From preceding test to close, the Old Crow is often induced to open door by feeding Young Crow 1 preceding each test.
201	" "	:30	Young Crow 1	1 with foot.
203	" 17	4:	Old Crow	Many trials necessary.
205	" 18	: 5	Young Crow 1	1
206	" "	1:50	Old Crow	4 Came round from rear often to see if door had been opened by efforts just made.
207	" 19	2:30	Young Crow 1	With foot.
208	" "	:10	Old Crow	
214	" 21	:10	"	

again once each in two different tests, twice again on Aug. 3rd, and again on Aug. 6th. On Aug. 6th the pan of food was removed from just behind the strings to the front left corner. He noted the change but it did not affect his behavior. After three tests the food was placed in the left rear corner but this again made no change in his behavior. It is understood, of course, that each time after the door was opened I placed the food out next the door-sill so that Jim could get it. He would probably starve before entering the box.

On August 5th one of two young crows that were taken from the nest about the first of June and reared by hand was turned into the cage with Jim. The accompanying figure 20, gives a good idea of the tameness of these crows, and yet they were, when a month or so old, somewhat more fearful than as shown in the photograph. If a stranger fed them they might refuse to eat from his hand until very hungry. This young one, which we shall designate as Young Crow 1, was at first inclined to be rather cautious in his approach to the box. On the second day, however, he struck at the wire and nail heads.

On this same day the strings were removed from their place at the right of the door, place 1, and placed to the left of the door, place 2. This change was identical with that made in the box for the birds in Series A and others. It will be seen from the table that nothing was done during seventeen and one-half minutes except some efforts on the wire eyelets where the old strings had been attached. In the 2nd test Jim made fifteen unsuccessful trials in ten minutes and then returned to his perch. In the following trial of ten minutes Young Crow 1 played a good deal on top of the box. The young crows had shown signs of play when in their own cage. Jim made three unsuccessful efforts, but failed in ten minutes. Young Crow 1 opened the door by pulling the top string when standing on top of the box. Jim had already made five attempts during this trial. In the succeeding trial Jim worked very hard. He was successful only after making forty-eight vain efforts on the old side. He seemed to have very strong associations with the old place and not for the strings. The box is so made that the door swings back against these strings. Jim's great fear may well have been increased by this fact. The time required for the next trial was longer. Seventeen errors, all made by working on the old place, were recorded against Jim in this trial. Young Crow 1 was working on the top of the door. He struck it with the beak and jumped back suddenly each time.

By this time Jim showed signs of learning to work on the strings in the new position. There was some little interruption during a few tests at about this time. This was caused by the



FIG. 20

The two Young Crows as they were usually fed. Such tameness was to be had as they grew older only with the most constant feeding and by the one person who cared for them.

fact that a turtle had been eating from the pan which contained the bird food, and in fact opened the door a few times by crawling up between the strings and the wire.

The Young Crow 1 worked at the box a great deal. He seemed to enjoy pulling and tugging at the rubber band which

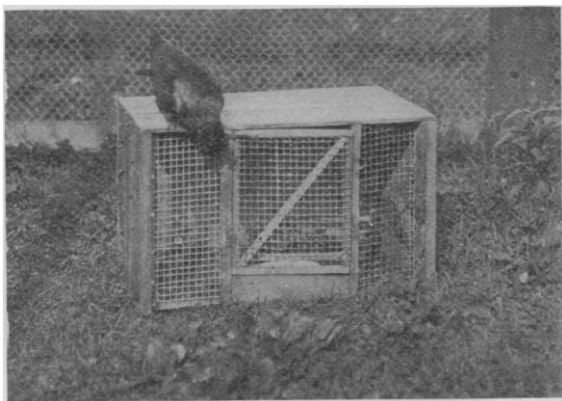


FIG. 21

The strings were now in Place 4 on left end. Young Crow 1 is shown here as he happened to find a way to open the door which I had not foreseen. He pushed his beak through the wire and pulled the strings as they run from the latch to Place 4. See the text (p. 63) for the effect of this on the Old Crow.

was used to pull the door open when the latch was raised. He had opened the door some three times in all prior to the 123rd test. At this time the strings were removed to the niche in the left end, place 3, but just around the corner from where they were. As may be seen from the results, Jim made this transition with very little if any difficulty. He continued to do so for four more tests when Young Crow 1 opened the door from the top of the box. In the next Jim struck at the string but missed, when Young Crow 1 at once pulled the same string. Both worked at exactly the same time in the third trial following. In succeeding trials the Young Crow often opened only after Jim had made one attempt.

On the 146th trial the strings were changed to the rear position on the left end. Jim opened the first time, but had to make three different approaches. He looked for the strings in the old position, as did the Young Crow 1 in the next trial, before working them in the new location. In the next two trials Jim made attempts on the old positions.

From the standpoint of imitation the results of this series now come to be more interesting. Young Crow 1 pecked at the top of the door a great deal. Young Crow 2 had now been placed in the cage. Jim struck the door sixty-two times or until Young Crow 1 pulled the string and opened it. The extent to which the latter understood what he was doing may be guessed from the fact that he went on pulling after the door was open. Young Crow 2 was successful next time, and he, too, continued to pull as the other had done. In the next Jim made seventeen errors by working on the door and the rubber band.

Several trials later Young Crow 1 stood on the ground and opened the door as Jim did. It is very difficult to classify this as imitation, though he did it a number of times, for the reason that this crow was so versatile. He did everything to the box in every way in which he could peck or pull at any part of it. He even went so far as to stand on the ground and pull the same string as Jim. Inasmuch as he had the same day stood on top and struck at the top string immediately after Jim opened by using the lower string we may call it imitation according to the more difficult criterion. It involved a change from previous behavior.

In order to make a place for the strings on the rear side of the box so that this series should correspond exactly with that on the Sparrows, etc., Series A, the boards were removed and posts and wire were put in on the rear, Fig. 22. This change made Jim and even Young Crow 1 afraid whenever they caught sight of the wire. This caused the times to be somewhat longer.

For the 4th trial following this change the strings were placed on the rear at the right corner. There now occurred a fortunate conjunction of circumstances more than once which has given me my best results on the subject of imitation in birds. Instead of opening the door as I meant for him to do, Young Crow 1, after about a dozen efforts, put the beak through the wire just to the right of the door in front and pulled one of the strings running vertically from the latch to the under surface of the top of the box, Fig. 21. The door opened and following his playful habit he jumped to the top

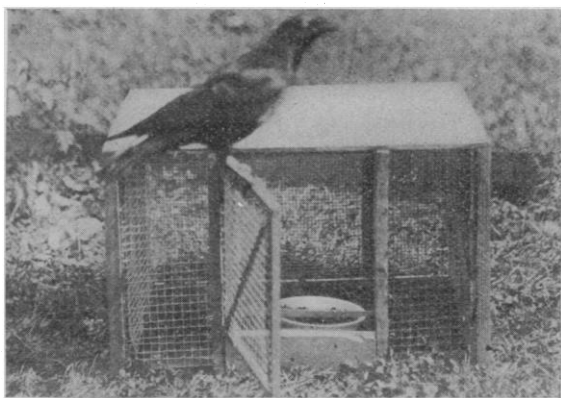


FIG. 22

Young Crow 1 at his favorite play with the box. He was swinging on the door. When he jumped off the door usually closed and he or the Old Crow must open again. This is important for it brings the tests in rapid succession, a very favorable condition for imitation.

of the door and swung back and forth a few times, Fig. 23. In hopping off the door, as he always did in a few seconds, he closed it and thus made possible another test *at once* after Jim had seen him open the door from in front. In spite of the fact that Jim had shown strong inclination to go to the left end, he now made most of his thirty efforts on the front and really succeeded in opening the door in the same way as the young one had done. In the next trial Jim opened by two hard blows on the door itself, for I had placed the strings so that they could not be reached through the wire.

For the following trial I had changed the box so that the door did not open so easily by striking against it. However, Jim struck it fifteen times and the Young Crow 1 outwitted me again by pure accident in lifting the door up when his claws extended over the edge of the box and caught in the upper

edge of the door. In the following trial Young Crow 1 opened in much the same indirect manner with the claws, but only after Jim had made thirty efforts with his bill. Again there were many efforts on the door, but this trial the young one pulled the strings as he should. This was followed by a test in which Jim made about fifteen unsuccessful efforts with his beak, but Young Crow 1 succeeded by striking through the wire at the left end of the latch. Previous to this I had changed the box so that no amount of pecking could open it, but now I had to cut off the end of the latch so that it did not extend out from the post to which the door was hung. From the fact that in the next trial this Young Crow 1 made many attempts on the door and front of the box, we infer that his records would give us a good curve of learning did he not alternate so much with Jim and were there not so many conditions necessary for Jim and tests for imitation, which were hardly calculated to permit of good results for the Young Crow 1 as a subject of mere learning tests.

From this point on to the close of these tests this Young Crow 1 opened the box except when he was fed just preceding each test and Jim was allowed to go hungry. Even then the former would sometimes be the first to perform the necessary act. See Fig. 23. This would indicate that his opening the box was often a result of what we might term his playful activity.

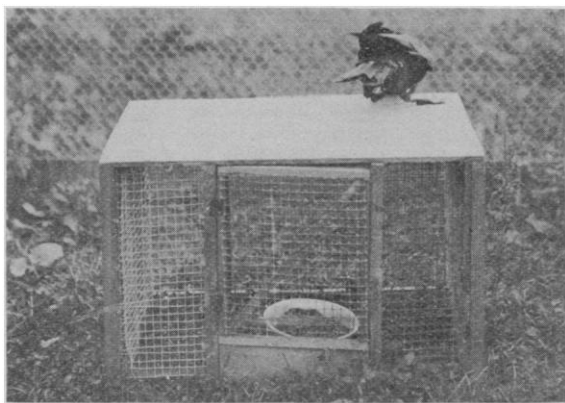


FIG. 23

Young Crow 1 shown opening the door by pulling String C in Place 5. The Old Crow was induced later to work in this place, but did so in his own way. The Young Crow was fed from the hand just before each test and as a rule made no attempts to open the box.

It is of interest to note that when Jim made a rapid but un-

successful pass at the string, he would often run around to the door, evidently expecting that his act had brought the desired result.

It would seem that in the present series there was a happy conjunction of just those factors needed to call forth imitation. May we not say that these are just the conditions and factors which render the experiment less artificial and less far removed from those natural conditions in which so many have taken it for granted that intelligent imitation did find a large place? The present writer is persuaded that what he needs with other birds and animals is a more or less exact duplication of the conditions which obtained with these crows.

Jim followed the example given by young Crow 1. He did not simply perform an act in the same way as his model did but in that part of the box worked upon as well as the definite things done he was seen to go against an old habit, against that which he was strongly inclined to do. He did so probably because previous methods of his own had brought the desired result.

Without great caution on the part of this older bird, frequent changes in the fastenings on the box, without the incessant playful efforts on the part of the young crow, indeed, without the imperfections in the box which made it possible to open it in an unexpected way, it is difficult to see how such a clear case of imitation could have been obtained. That this is the best series which the present writer has to submit is largely due to results unforeseen but which nevertheless may serve us all the better as proof of that which we were in search of. But it may be said that many of the changes which the Old Crow made in his behavior were simple reversions to a previous method of his own. True this may be in many cases and yet this very point is involved if we analyze the conditions necessary for the appearance of imitation. Where could the idea or impulse of the movement to be made in imitation come from if the animal or child had had no previous experience of its own to use at least as a basis. In an important way this previous experience is just what has not been given to animals by earlier students of imitation. The lack of this previous experience in sufficient amount is perhaps the chief reason for the fact that it is some months—four to six—before the higher stages of imitation appear in the human child.

VI. DISCUSSION OF RESULTS

The origin and development of social life in the animal as well as in the human world have long been considered problems by scientists, whether biologists, sociologists, psychologists, or educators. Imitation of some kind or other, all

would agree, constitutes one and only one of the chief factors in this problem. The interpretation of our findings, stated in the previous sections, may be dealt with briefly here.

Let us consider the different kinds of imitation. Principal Morgan, that peerless thinker in the problems of Animal Behavior, has proposed the following:

(1) Mimicry, which lies below the level of imitation and which (the present writer would add) is determined by forces wholly outside the individual. Mimicry is determined for the individual in the previous history, or, let us say, experience of the species, either through environmental or organic conditions. Some recent investigations give promise of serious revision of our thought with reference to just why the walking-stick, for example, is so like the branch on which it is found. At any rate, it is the experience working through natural selections and other ways, and not at all necessarily through transmission of acquired characters, that pre-determines Mimicry in the individual. The reason for the writer's use of the word experience will appear later.

(2) Instinctive Imitation. This is again inherited though now the emphasis, because of the meaning of the word "Instinctive," is on function rather than structure. Partly because it is function rather than structure, but also because of the nature of the external stimulus which sets the instinct going, it is to be expected that what the individual imitates instinctively will not be copied in so fixed a manner as mimicry demands. There will be a good deal of the individual in it. Nevertheless such instinctive imitation is done readily and automatically, and is determined by the experience of the species. It belongs in the same class with mimicry, but offers more of plasticity of action to the individual. They therefore have the same relation as Hobhouse has pointed out for Reflex Action and Instinct. Examples of instinctive imitation are to be found in the "following instinct," which is very well illustrated by the observations described on page 6. Many, if not all, of the instances of imitations of song in birds are examples of instinctive imitation. The calls and songs of birds are very intimately associated with the mating as well as other instincts. Some of these might well become intelligent after being performed the first few times.

(3) Intelligent Imitation. Until the appearance of his most recent work on Animal Behavior this formed the last and highest part of Morgan's classification. In this book, however, this author makes a distinction which the present writer deems most necessary and useful, but which needs to be carried further.

All other earlier writers separate too widely instinctive and

intelligent imitation. Most have made intelligent imitation synonymous with "reflective," "intentional," "voluntary," "persistent" and hence this wide separation was very natural and even necessary. Inasmuch as students of animal psychology have agreed to use intelligence to mean "profiting by experience," and not reason, it would seem that intelligent imitation should be kept apart from the words which seem to imply in the animal mind something which is akin to, if not identical with, reasoning. The writer then proposes, and this is done chiefly because the facts seem to require it, as a third class that of intelligent imitation.

(4) Reflective, Intentional or Voluntary. This class involves an analysis of which, as can be shown, the bird is not capable. At least the observations which I have made would seriously call it in question. Such are those errors which have occurred in almost every one of the series described—pulling the strings repeatedly with the door already open, the indirect method used by the White-throated Sparrow, the errors of the Bluebird even in the Memory series, the errors and following up of misleading acts by the Orioles and Crows, etc. A fuller discussion of the significance of these facts would be both interesting and profitable in affording us an insight into bird mind, but it is hardly necessary here.

We have seen that mimicry and instinctive imitation are predetermined for the individual by the experience of the species. Has it not been rather futile for us to expect that one animal should imitate another in the doing of some act which each individual animal must learn by the "trial and success" method and this only? Most students of animals agree that it is by individual experience that such a thing is first learned. Then here is a test such as pulling a string to open a door to get food, which is extremely artificial from the animal point of view. How artificial it is only those can appreciate who have observed the enormous number of different things birds will do before pulling such a string much less to imitate another's pulling it.

The criterion which is proposed, stated on page 8, makes the test more difficult for the animal. He must change his own method for that of another. All my work with birds would lead me to expect that each species will probably open the door, such as I have used most, in a few limited ways. One feels that the Cowbird will use the beak or stand on the floor and pull with one claw. Several English Sparrows who have been very wild have used the same method of flying out from the top of the box and barely alighting on the strings. Yet even this fear may be an incentive to their following a copy set by another bird, and changing from their former method to the

one to be imitated. If other higher animals such as House Mice were worked with, I should deem it very necessary to make it certain that odor could in no way be used as a constantly leading stimulus for the animal doing the imitating. With birds such precaution is hardly necessary. It is considerations such as these which seem to demand a change of method in order that we obtain attention and interest from the animals, make our experiments more natural, and use a criterion which is more rigid so that what we have left, after we have rejected all that does not measure up, shall be really true.

As is evident from the detailed results, we do get examples of intelligent imitation. I do not call it voluntary, reflective, rational, or intentional. If animals are intelligent but not rational, this is all that we should expect. Such imitation is as stupid, as blindly dictated by accident and satisfaction and discomfort, and as impulsive as the intelligent act *per se*.

The writer hopes at some later time to show that much of human learning is analogous, not necessarily homologous, with animal learning. Both learn by "trial and success," the happy accident and the painful result method. Indeed man does not reason by far as much as our popular notions concerning this question would lead us to suppose. If this is true, then imitation in children and the higher animals ought to bear some instructive analogies.

The writer has three children. One is now two years old, another nine years and another eleven. Child psychologists record the fact that imitation appears first in a noticeable way about the fifth month. They mean, of course, the appearance of reflective, or better perhaps, intelligent imitation. I have several observations on the youngest child for the fifth month and thereafter which show clearly as it seems to me, that her imitations took the form of those things, or closely similar to experiences, which I had noted she had been having in an entirely spontaneous way. She imitated the nine-year-old in producing a high tone long drawn out. But it was not until after several repetitions that she knew she was doing so. This knowledge was indicated by the quite marked change in facial expression. So with a half dozen other cases in which there were pretty clear signs of imitation. All were based on previous experience, however. It has been observed often, as no doubt has been done by many others, that the baby shows much more interest and attention to what is done by the sister nine years of age than to the behavior of adults.

After the child referred to above had performed the imitation a few times, each performance being followed by all kinds of approval by one or more adults, and renewed efforts to elicit more, there were signs of a consciousness on the child's part

which promised to cause such acts to become rapidly imitation of a reflective, voluntary or intentional kind. As they first occurred they were to me examples of intelligent imitations, prepared for by the child's own experience.

It may not be amiss to ask what it is which characterizes those acts which adult persons imitate in an unreflective way? Does the preparation we have had, the previous experience, have the same effect as we think it has for these birds, only for the latter in a far more restricted manner?

There are, then, many reasons for believing that it is possible by giving a bird previous experience with the object to be worked with to get that sort of imitation which may be called intelligent. This probably is on a little higher level than instinctive, and yet does not mean the same as reflective, intentional, or voluntary. The writer hastens to say, however, that he really believes that any classification of the above kind does not adequately represent the facts. The observed facts in the animal are of all stages of instinctive and intelligent and in the child these two are not left behind when they emerge into the reflective. In this instinctive basis we find a satisfactory explanation of the facts concerning imitation in bird songs. There is probably no distinction to be made here between that which is instinctive from that which is intelligent. Were it possible to come to the bird with an act for it to imitate, which would appeal as naturally, spontaneously and repeatedly as these call notes and songs do, then we should probably get intelligent imitation as unmistakably and easily. This is difficult, but the writer feels that with the long series of tests under the conditions imposed and the demands of the more difficult criterion, we may be more certain of getting examples of intelligent imitation; but hardly that which is distinctively human,—the reflective, intentional or voluntary.

VIII. SUMMARY

1. Several long additional series of experiments on the intelligence of the English Sparrow and Cowbird have been obtained. The rate of learning is slower than that found earlier, but my present conditions were different inasmuch as the primary object here was to get results on imitation. This should be kept in mind by the reader in connection with all the tests here described. The Cowbirds spent much of their time in looking for parasites on the Sparrows and parts of the cage.

2. The male English Sparrow showed signs of imitating the female Sparrow, and more unmistakable signs of imitating the Cowbird. His latest change in behavior satisfied the requirements of the criterion which the writer from previous

results has been led to adopt. For a statement of this criterion see page 8. We not only obtain a more rigid standard, but we are more certain that Bird No. 1 really sees, is interested in, and attends to what the other is doing. It has had such experience with the apparatus, that it is more likely to be interested in what is done in order to open the box.

3. If the Cowbirds did start a series, as they often did, the English Sparrows after a few tests displaced them.

4. This may be accounted for by the fact that the English Sparrow is far more active and though much smaller, often drove the Cowbirds away and held them at bay even after a bitter struggle.

5. The Junco learned to open the food-box, but not until after the female English Sparrow had taken the lead. There was keen rivalry and fighting between them. There was probable imitation of each by the other of the intelligent sort.

6. The White-throated Sparrow and Field Sparrow learned to open the food-box though not so rapidly as some of the other birds. This slowness may be due to the indirect method of the former, to the small size of the latter, and to the fact that both were tried in a cage near the entrance to all the cages, and hence were disturbed a good deal.

7. A young Song Sparrow for a few tests showed signs of rather rapid learning. There were a few uncertain signs of imitation of the intelligent sort with the White-throated, Field, and Song Sparrows and the Junco.

8. In a long series of tests on a pair of Bluebirds, White-crowned Sparrows, and two each of Juncos and Tree, Fox, and Song Sparrows, the best fighters were the ones to open the door early in the series. The male Bluebird early began to lead and finally was the only one to do it. Here again there were some uncertain imitative acts on the part of each Bluebird, but chiefly by the female. A memory series for these Bluebirds showed that they had forgotten little in one month. It also revealed some errors on their part which indicated that such memory of the place to alight upon did not mean that they had at any time analyzed the mechanism of the box. Some learning tests on another male Bluebird, who was alone in the cage, showed that he was very slow in starting.

9. A long series of tests with a pair of Blue Jays gave no results on imitation, but did give good evidence of the male's power to learn. But when the strings were changed he did not adapt himself as readily as the English Sparrow. However, it was still possible for the Jay to use his old method. This of course makes it impossible to generalize from these tests.

10. In experiments on three Cowbirds,—two males and one female,—two young English Sparrows and a male Balti-

more Oriole, one of the male Cowbirds first opened the door but the Oriole soon displaced him and learned to do it in his own way. Later a more pugnacious Oriole was placed in the cage. He soon was the one who opened the door. There were signs of imitation here, although he did not use the method Oriole No. 1 used. Later Oriole No. 1 imitated Oriole No. 2.

11. When the strings were changed these birds did not show as ready adaptation as the English Sparrow. This may be due to the fact that it was still possible for Oriole No. 1 to use his old method which he did.

12. The old crow was so cautious that beginning tests with him were long, and there were many efforts. He learned rapidly when once started. He adapted himself to the first change in the position of the strings on the box with less readiness than the female English Sparrow. With the second and third change his results were quite comparable with the female English Sparrow's. For the fourth change the Young Crow 1 interfered. The crows, largely because the Young Crow 1 in his incessant play with the box aided materially in bringing about favorable conditions, furnish us with the best examples of imitation. This is so from the fact that the old crow was led through imitation to change his method of opening the door. The more rigid and difficult criterion is thus shown to be practicable here as well as with the Orioles, the Junco and English Sparrow and Cowbird.

13. In those series where it was possible to obtain data it is somewhat evident that birds of the same species imitated each other more readily than the members of a different species. Yet the latter has occurred twice at least.

14. In the case of nearly every bird which really learned to open the door, we have found repeated pulling of the strings with the door already open. This with the behavior of the birds when the strings were changed to a new position and opening the door in the old place, if such was possible, point to the fact that there was not much analysis of the relations of the situation or parts of the box.

15. In view of what has just been said, it would seem advisable to suggest Intelligent Imitation as a new class leaving the words "reflective," "voluntary," or "intentional," for that which is probably to be classed as distinctively human.

Some of the results of the present paper were presented before the Section on Animal Behavior at the meeting of the International Congress of Zoölogy which met in Boston, 1907. All of the results of this paper together with others were made the basis of a report at the Chicago meeting of the American Psychological Association (1907-08). In a somewhat modified form this same study was awarded the Walker Prize of the Boston Society of Natural History in 1908.